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THE PRESENT STATUS OF ANATOMY.[1]

J. PLAYFAIR McMURRICH.

It is a prevalent belief among the laity that anatomy is a practically completed study, that there is little or nothing to be added to our knowledge of the structure of the human body; and for such a belief there is a certain amount of excuse. The human body has been an object of anatomical study and investigation for centuries; hundreds of volumes, ranging from duodecimos to folios, have been written about its structure; thousands on thousands of bodies have been dissected; and why, then, are we not in possession of a full knowledge of the subject?

Such reasoning overlooks the fact that in every science there is not one but two elements, the material and the intellectual, which react upon one another, new observations producing new generalizations, and these again pointing the way to new fields for observation. But the misconception as to the present status of anatomy depends upon a misconception of a more fundamental idea, *i.e.*, of what is meant by science. To the popular mind science is merely the collecting of natural facts. The

[1] An address before the Catholepistemiad Club of the University of Michigan, Dec. 16, 1898.

scientist is pictured as an inquiring Gradgrind, who seeks for facts, facts, and nothing but facts; he weighs, he measures, and he describes; and weighing, measuring, and describing constitute science. No! The collection of facts, no matter how accurately accomplished, is no more science than the alphabet is literature. As Huxley has well put it, "the mere accumulation of facts without generalization and classification is as great an error intellectually as, hygienically, would be the attempt to strengthen by accumulating nourishment without due attention to the primal *viæ*, the result in each case being chiefly giddiness and confusion in the head." Observation alone is not science; facts without deduction are merely the clay without the straw. Observations, accurate and extensive, are a primal necessity, but observation alone merely furnishes the crude material from which, by reflection and deduction, scientific facts may be obtained.

So then, what is usually regarded as the whole of anatomy — descriptive anatomy — is not necessarily a science; it constitutes merely an aggregate of facts upon which deduction may act, and it is the sum-total of the observations and deductions that constitutes the science.

The purpose of this address is to consider chiefly the general standpoint of anatomy as it is at present, but a few words seem necessary concerning the more observational side. The facts or observations at the disposal of the anatomist of to-day are enormously more numerous and detailed than those available at, let us say, the beginning of the present century; and this progress along the material side has been largely due to the greater facilities for observation which we now possess. The anatomists of the sixteenth and early part of the seventeenth century possessed only such information as was afforded by the use of the scalpel and their unaided vision. In the seventeenth century a new tool was placed in their hands, the microscope, without which the anatomist of to-day is well-nigh helpless. At once new fields for observation were revealed and many new facts were secured, though for many years the microscope was rather a plaything than a tool. Indeed, it was not until the present century was well advanced that the optical imper-

fections of the compound microscope were overcome and the instrument we now so constantly employ was within reach.

But, after all, the microscope, *per se*, in anatomy has enormous limitations. A fragment of tissue taken from the body and placed at once beneath the strongest powers of the microscope yields but few of its secrets. The great development in the modern use of the microscope, if I may so express myself, has been in the methods of preparation of the tissues to be examined, methods which have become so familiar to workers with the microscope that they are apt to forget how very recent they are. The hardening of tissues was not introduced until the beginning of the present century (Reil), and then alcohol alone was used; the processes of "fixation" previous to hardening had their origin in the discovery of the value of osmic acid for this purpose by Max Schultze in 1864; section cutting, even free-hand, was not generally employed until after the middle of the present century; staining was first employed by Gerlach in 1858; and mounting in refractive media was introduced by Stilling about the same time as section cutting (1840).

How rapid, then, has been the development of our modern methods! To-day instead of one "fixative" we have our choice of many; instead of cutting our sections with the free-hand and spoiling many, we have instruments of precision by which we can cut an entire organism or a piece of tissue into sections $\frac{1}{2500}$ of an inch in thickness without spoiling one, and, if necessary, can obtain sections of $\frac{1}{10000}$ or even $\frac{1}{25000}$ of an inch, so perfect have our methods become. While Gerlach knew only one medium for staining, namely, carmine, to-day we have dozens, the discovery of the anilines placing in our hands a marvelous aid to microscopical investigation. By their use we can differentiate tissues. One dye will have an affinity for nerve tissue, another for yellow elastic tissue, another for mucin; others will affect most strongly the chromatin of the cell nucleus, others the cell body or cytoplasm, and so on; and thus, by choosing the proper method, it is possible to differentiate structures in a most marvelous manner.

So then the anatomist of to-day, by the proper employment of the methods at his disposal, has it in his power to make

observations undreamt of, in their minuteness, by the masters of fifty years ago, and wonderfully more perfect than those possible even fifteen years ago. How then, even from the observational side, can anatomy be a completed science?

But now, leaving this side of the story, let us examine the difference between the higher intellectual side of anatomy as it is to-day and what it was in the past.

It is interesting to note the impartiality of the intellectual stagnation of the Middle Ages. The neglect of Aristotle, so marked in philosophy, is paralleled by a similar neglect in the department of Natural History; Pliny, with his fabulous tales and uncritical compilations, being the great authority. In anatomy the condition was largely the same. Original observation was almost neglected, utmost reliance being placed upon the *dicta* of Galen and any attempt to criticise his statements regarded as a heresy. When, accordingly, Vesalius, in the first half of the sixteenth century, disregarding the dictates of antiquity and entering upon a course of investigation for himself, pointed out that the facts which Galen set forth as applicable to the human body, and which were in reality founded largely upon observations made chiefly in dogs and monkeys, were in many particulars erroneous, he encountered a storm of derision and obloquy. The correctness of his observations had to be recognized however, though with great unwillingness; but even then his opponents, notably his former teacher, Sylvius, maintained the correctness of Galen's descriptions and endeavored to explain away discrepancies by asserting that the structure of the human body must have changed since Galen's time. Vesalius had pointed out that the bones of the leg are not curved, as Galen had asserted. "Granted," cried his opponents, "but they were curved in Galen's time, and their straightness now is due to the substitution of close-fitting garments for the flowing robes of earlier times."

On the death of Vesalius in 1564, the influence of his opponents produced a revival of Galenism, but the leaven had begun to work and the zeal of Vesalius had marked an epoch in anatomy. Careful observation and description became more and more the order of the day, and led in 1619 to the dis-

covery by Harvey of the circulation of the blood, a discovery which marked a second great epoch in the history of anatomy. It laid the axe at the root of the spiritual theories prevalent at the time, which recognized as the essence of life an unknown something, the *spiritus* or *aura*, which, being confected in the liver, served to distend the heart, whence it was distributed as a *spiritus naturalis* by the veins to certain organs of the body, and as a *spiritus vitalis* to others by the arteries. Harvey's discovery necessarily proved a serious blow to such vague ideas, though in one form or another they continued to exist for nearly two centuries, the *spiritus* being a ghost difficult to lay. Harvey showed that the heart was not passive, but was a muscular pump, that the heart and not the liver was the starting point of the circulation, that the blood of the arteries and of the veins was the same, and that the course of the blood in both sets of vessels was in a definite direction. And by so showing he laid the foundation stone of our modern science of physiology.

But the seventeenth century is entitled to the credit of laying the foundation stone not only of physiology, but also of microscopical anatomy and of comparative anatomy. Leeuwenhoek, polishing his own lenses and subjecting to their action whatever came to his hand, made many important discoveries, chief among which appear bacteria, the yeast plant, and spermatozoa; and Malpighi discovered the blood corpuscles and completed the missing link in Harvey's scheme of the circulation by describing the capillaries by which the veins and arteries are placed in communication.

The interest awakened in human anatomy in the sixteenth century was not accompanied by an equal interest in the study of the lower forms, but towards the close of the seventeenth century comparative anatomy was again called to the aid of human anatomy by Nehemiah Grew, by Tyson, who availed himself of an opportunity for dissecting an ourang and carefully compared its structure with that of man, and by Collins, who with Tyson's aid illustrated the structure of the human body by references to the peculiarities of structure found in the lower animals.

And, finally, as a crowning glory of the seventeenth century, we must not forget the inauguration in it of the science of embryology, with which the name of Harvey must also be associated, his predecessor in the study being his teacher, Fabricius ab Aquapendente.

But it is merely the beginnings of these various adjuncts to anatomy that we find at this period. At this time, and indeed until much later, anatomy was regarded simply as a medical study, and investigation in it was conducted for a distinctly practical end. On account of its relations to medicine it came under the influence of the medical theories which prevailed at the time, and these theories, frequently changing, at one time stimulated observation and at another retarded it. Anatomy, instead of flourishing under a theory of its own, was overshadowed by, or received but reflected lustre from medical theories, and it is of interest on this account to consider these latter briefly.

If I were asked to characterize in a few words these theories, I would say that they belong to two distinct classes, those of the one class being based upon a dualistic conception of the structure of the body, while those of the other might be termed monistic. Those of the one class seem to have served as stimuli to those of the other, and the history of the theory of medicine from the sixteenth to the beginning of the nineteenth century has been a history of an almost regular alternation of dualistic and monistic hypotheses. As pertaining to the dualistic group, the sixteenth century doctrines of Paracelsus may be mentioned, according to which the physiological and pathological processes of the body were the result of a controlling spirit, termed the *Archeus*, and this view was also maintained with slight modifications by Van Helmont in the beginning of the seventeenth century, he, too, recognizing a dominant Archeus to whom were subordinate other *Archei insiti*, disease being due to "the passions and perturbations of the Archeus," and the treatment of the physician an attempt to modify the ideas or emotions of this *ens*.

Naturally there was ere long a reaction from such a fantastic hypothesis, and we find in the seventeenth century two monistic

schools, the Iatro-chemical and the Iatro-physical, which, as their names indicate, regarded the physiological processes of the body as chemical or physical in their nature. These theories were, however, too advanced for the times, and even Sylvius, the chief exponent of the chemical school, while regarding many diseases as the result of disturbances of the chemical processes of the body, still held to the idea of a *spiritus* when it was a question of nervous disturbances.

Later, at the beginning of the eighteenth century, Boerhaave emphasized the monistic views, and to a certain extent combined the principles of the two schools just mentioned by finding the causes of disease in the degree of cohesion of the particles composing the elementary fibres of the body and determining their strength or feebleness, their laxity or tenseness, and in the chemical and physical characters of the body fluids, their acidity, alkalinity, or viscosity. And almost at the same time we find a revival of the dualistic idea in the animism of Stahl, who revived to a certain extent the Archeus of Paracelsus under the name of the "anima" as the controlling element of the physiological processes of the body.

But it would take too long to even merely touch upon the numerous theories which marked the eighteenth century as the age of systems. The desire then prevalent of establishing a general principle which would govern the practice of medicine seems to stand in close relation to the tendency to establish systems which became evident in the philosophy of the times, and, if time permitted, it would be interesting to consider the influence of such minds as Descartes and Leibnitz on the medical theories of their day.

To a certain extent these various and vacillating theories retarded the progress of anatomy and physiology, but not entirely so. For a theory is merely a working hypothesis, an index of the lines along which further observation should proceed, and so, even though it may be fundamentally erroneous, it need not necessarily obscure for long the progress of thought, the observation which it stimulates soon correcting it and substituting for it more accurate ideas. The search for the elixir

of life yielded many valuable results to chemistry; for, as Cowley has expressed it:

> So though the Chymist his great secret miss
> (For neither it in art or nature is);
> Yet things well worth his toil he gains,
> And does his charge and labour pay
> With good unsought experiments by the way.

And so, though under the influence of erroneous theories and in an attempt to elucidate by commentaries the physiological ideas of Boerhaave, Haller, between 1746 and 1765, added greatly to the knowledge of anatomy and placed another stone on the foundation of modern physiology by the discovery of the contractility of muscle and the irritability of nerve.

The close of the century, or, rather, the beginning of the nineteenth, was marked by the appearance of a work of far different calibre than the majority. I mean the *Anatomie générale* of Bichat, published in Paris in 1801. Bichat combines, to a certain extent, the monistic tendencies of Boerhaave with the animistic ideas of Stahl, but, making use of Haller's discovery and by adding much of his own, he evolves a much more scientific and progressive system. He recognizes Stahl's animism as a pure abstraction and supplants it with two physiological processes, the irritability and contractility of Haller, which, he claims, are properties of all organs of the body and not of nerve and muscle alone. Digestion, circulation, secretion, in fact all the functions, are performed by the interaction of these two processes. So far this is an improvement in Stahl's ideas, but the great importance of Bichat's theories rests in that he makes these vital processes reside in the solids of the body. They are not absolute entities controlling the functions of the body, but in a sense they are these functions, and since disease is a disturbance of the functions, a modification of the vital processes, it is dependent upon a modification of the solids or tissues of the body.

Such a theory necessarily led to a more minute and careful study of the finer anatomy of the organs of the body, both in health and disease, and indeed was the result of such studies carried out largely by Bichat himself. That the body was com-

posed of numerous organs was clearly understood, but Bichat pointed out that the structure and function of an organ is dependent upon components, the tissues, which enter into its formation. To quote his own words: "Every animal is an assemblage of different organs, which, each performing a single function, subserve, each in its own way, the preservation of all. They are so many special structures in the general structure which constitutes the individual. Now these special structures are themselves formed of several tissues of very different natures, and which, indeed, form the elements of these organs. Chemistry has its simple bodies, which form, by the various combinations of which they are capable, compound bodies; such simple bodies are heat, light, hydrogen, oxygen, carbon, nitrogen, phosphorus, etc. Similarly, anatomy has its simple tissues, which, by their combinations in fours, sixes, eights, etc., form the organs." Elements of lower grade than the organs had been postulated in earlier times; thus Boerhaave speaks of elementary fibres which form certain structures and Asclepiades, still earlier, applied to anatomy the Epicurean doctrine of atoms. But one of these was a philosophical abstraction and not a scientific hypothesis, and the other a crude generalization not applicable to all parts of the body. Bichat's tissue element is, however, accepted to-day as an individual of simpler grade than the organ individual, and though we do not recognize as perfect his definition of tissues or his enumeration of them, yet the ground idea is the same, except in so far as it is influenced by the cell theory of a later date.

If, now, the epoch-making discoveries in the history of anatomy in the sixteenth, seventeenth, and eighteenth centuries were to be summed up briefly, there would be placed first and foremost the overthrow of the Galenian traditions, and the revival of observation by Vesalius (1516–34); next the discovery of the circulation of the blood by Harvey (1619); next Haller's discovery of the irritability and contractility of nerve and muscle (1746), and, finally, the formulation by Bichat of his tissue elements and the overthrow of both the ultra-physical and the ultra-animistic theories of disease (1801).

During all the period hitherto considered anatomy remained

very largely in the observational stage, and was ancillary to medicine. In the mean time, however, investigations were proceeding in allied branches of biological science, which were destined eventually to place anatomy in the category of the sciences.

In Germany, Johannes Müller and Meckel; in England, Hunter, Home and, later, Owen; and in France, Vicq d'Azyr, Étienne, and Isidore Geoffroi St. Hilaire, Lamarck and, especially, Cuvier, prosecuted with vigor and enthusiasm the study of comparative anatomy, the results of their observations calling into existence two diametrically opposed deductions, on the one hand the doctrine of Types espoused by Cuvier, and on the other that of Transformationism, upheld by Étienne Geoffroi St. Hilaire and Lamarck. Cuvier's theory, briefly stated, was that in the animal world there was a definite number of structural types or plans, to one or other of which every animal could be referred. The theological bias of the theory was strong; the plans or types, having existed in the mind of the Creator from the beginning, were fixed and immutable; connecting links between them were impossible; they were circles whose boundaries might touch but could never overlap. And, furthermore, the theory involved the idea of a special creation for each species, the species being consequently as immutable as the types. Man, therefore, was structurally isolated, and the similarities known to exist between him and lower forms could have no significance.

To Lamarck and St. Hilaire the facts of comparative anatomy pointed to entirely different conclusions. To them there was a fundamental unity in the animal kingdom; as some one has said, they took a synthetic, and Cuvier an analytic, view of nature. This unity was possible only by an absence of a fixity of type, by a mutability of species, and these were the ideas they opposed to Cuvier's scheme of creation, the ideas of transformationism or evolution practically as we now understand it.

The controversy between the two schools was prolonged and bitter, and culminated in the celebrated passage of arms before the Academy of Sciences in Paris, which, to Goethe, seemed more important than the victories of Napoleon. The enormous

authority of Cuvier and the theological bias of his theory gained the day, however; the doctrine of transformationism retired temporarily from the field, and anatomy retained its isolated position.

Attention has already been called to the inauguration of the science of embryology by Fabricius and his pupil Harvey. During succeeding years it languished somewhat, but was finally established as an important branch of biology in the present century by the publication of the *Beobachtungen und Reflexionen* of von Baer in 1829. A masterly study of the development of a number of vertebrate organisms led von Baer to formulate a principle of developmental unity by his doctrine of the germ layers, and also to establish an idea of transformationism for the individual by demonstrating that in its development the organism proceeds from a more generalized to a more specialized condition; that is to say, it presents first what for convenience may be termed type characteristics, later the family, then the generic, and then the specific peculiarities being added or superimposed.

About the same time important ideas were working out in another department — that established by Malpighi and Leeuwenhoek — microscopical anatomy. Improvement of the microscope made possible the discovery in 1838 by the botanist Schleiden of cells as the ultimate structural units of plants — a discovery completed in the following year by Schwann, who extended the generalization to animals, and at the same time materially modified the meaning attached to the word *cell*. These discoveries were the following out of the idea of analysis suggested by Bichat, and were indeed the analysis of his tissue elements into individuals of a still lower grade. A further step was, however, still necessary to convert the cell-theory of structure into its modern form, and that was the formulation of the protoplasmic theory by Max Schulze in 1861. Just as cells had been known long before the cell theory was postulated, so, too, protoplasm had been known ever since the amœba was first observed by Rösel von Rosenhof in 1755. The attention to the nature of the cell contents, awakened by the cell theory, led the botanist von Mohl to recognize in vegetable cells a viscous

material distinct from the cell sap, to which he gave the name protoplasm. This was in 1846, but even before this Dujardin, in 1835, had described what he termed the *sarcode* in the Foraminifera. Schulze much later identified these two substances and modified the original cell theory by making a mass of protoplasm, independent of any special bounding wall, such as the word *cell* implies, the unit of structure. He converted Bichat's tissue elements into aggregates of protoplasmic elements, and, by extending his generalization to plants, made possible Huxley's characterization of protoplasm as the "physical basis of life."

All these discoveries and hypotheses were contributing to prepare the mind of the scientific world for the reawakening of the doctrine of evolution. The theological bias and the influence of Cuvier were still powerful at the middle of the century, but they could not withstand the march of observation and deduction which was tending surely to the overthrow of the Type theory, a result accomplished by the publication of Darwin's *Origin of Species* in 1859. Darwin's generalizations and the resulting acceptance of the theory of evolution at once placed anatomy in a new position. It could no longer be held aloof from the other biological sciences. Man is not an organism entirely distinct from all others; he is merely the culmination of one line of evolution. His structural peculiarities are not minute details of a primary immutable plan, but are to be explained by reference to his past history. Departures from the typical conditions, so frequent and in many cases so remarkable, are not mere vagaries without significance, but are reminiscences of previous conditions or indications of developmental possibilities frequently brought to completion in other forms.

The doctrine of evolution is the "one increasing purpose" whose influence is traceable throughout all science, and it has consequently broadened all our views by bringing the various departments of research into interdependence with one another. This is the age of specialties, and necessarily so, since the volume of knowledge has grown too great for one finite mind to comprehend the whole; but now, more than ever before, there is necessity for correlation. Each department of science

no longer stands isolated; no longer can a thorough and extensive research in any specialty be conducted without reference to other specialties and other departments. And it is this which stands out so clearly in the science of anatomy as it is to-day. It is no longer an isolated study, but merely a part of a wider field of knowledge. In the past it was a land-locked sea, but the erosion of the smaller streams of discovery and, finally, the overwhelming flood of the evolution hypothesis swept away the barrier which separated it, and it is now a small bay of the great ocean of morphology. In the past anatomy was human anatomy; to-day it is synonymous with morphology. No longer do anatomists confine their attention to merely accurate descriptions of the details of the structure of the body; they seek to discover the significance of these details. Anatomy has become "denkende Anatomie," to use the expression of Johannes Müller; it is no longer tied to the apron-strings of its mother, Medicine, but, having come of age, has taken its place in the rank of the sciences, the *Origin of Species* and the *Descent of Man* having been its Declaration of Independence.

How, then, can our knowledge of the structure of the human body be complete? Modern anatomy is not yet fifty years of age, and this is infancy compared with the sister sciences. All that has been accomplished from the time of Aristotle to the middle of the present century was largely merely a preparation, and the time that has elapsed since then has been far too short for the solution of all the problems which confront us. Goethe has said of another department of study: "History must from time to time be rewritten, not because many new facts have been discovered, but because new aspects come into view, because the participant in the progress of an age is led to standpoints from which the past can be regarded and judged in a novel manner." So it is with anatomy; the new standpoint calls for a new interpretation of anatomical facts and a restatement of our knowledge of anatomy.

It seems unnecessary to run the risk of tediousness by enumerating the problems of anatomy of to-day, their number being endless. I trust I have made its present standpoint clear, so clear that he who will may read between the lines and

see that an anatomist can do as much, indeed I would even say he can do more for the advancement of his science by prosecuting investigations in comparative anatomy and embryology than by confining his attention to man alone. Why should the anatomist, endeavoring to unravel the mystery of the structure of the most complicated organism known to him, waste his time and energy in studying that organism alone, when he can trace step by step the gradual increase of the complexity in the lower forms of life, and, by learning to understand the simpler conditions, place himself in a position to understand the final complexity?

More than one hundred years ago the Abbé Dicquemare wrote: "Everything that relates to animals, their manner of being, the growth and diminutions which they show, their generation, their strength, their actions, their diseases, their nourishment, the duration of their lives, the phenomena which they manifest even in death, all these are subjects which ought to interest man. If his moral being does not offer any analogy to theirs, his physical constitution permits comparisons." The new anatomy is interested in all these subjects; it is catholic in its extent. From amœba to man every organism falls within the jurisdiction of the anatomist, and there is no problem of morphology but is his for solution, no observation however insignificant but is his for application. "Neque enim ad agendum et potestatem sive operationem humanam amplificandam sufficit, aut magnopere attinet, nosse ex quibus res constent, si modus et vias mutationum et transformationum ignores." These words of Lord Bacon would well serve as a motto for the anatomy of to-day.

PSEUDOMONAS CAMPESTRIS.

Behavior in gelatin containing varying amounts of Sodium hydrate. (See Gelatin Culture Media, — 2d Ann. Meeting Soc. for Plant Morphology and Physiology.)

THE SECOND ANNUAL MEETING OF THE SOCIETY FOR PLANT MORPHOLOGY AND PHYSIOLOGY.

ERWIN F. SMITH.

THE second annual meeting of this society was held in New York, December 27–29, in affiliation with the American Society of Naturalists. All of the meetings were held at Schermerhorn Hall, in the new and very commodious quarters of the Department of Botany of Columbia University. The Torrey Botanical Club gave a reception to the society and visiting botanists on Tuesday evening, and throughout the meetings the New York botanists did everything that was possible to make the occasion pleasant and profitable. Five papers listed on the programme were not read owing to the absence of the authors, some of whom were detained by sickness. There were, however, more than enough papers to fill the allotted time, and the second meeting of the society closed as successfully as the first one. Professor Macfarlane was elected president for the ensuing year. The following additions were made to the membership of the society: Newcombe, Pollock, Underwood, Waite, Stewart, Halsted, Johnson. In addition to the papers abstracted below, Dr. W. G. Farlow, as retiring president, gave a very interesting address on Peculiarities of the Distribution of Marine Algæ in North America, and the secretary of the society, Dr. W. F. Ganong, gave a ten-minute address before the whole body of naturalists on Advance in Methods of Teaching Botany. Dr. Ganong's address was printed in *Science,* January 20. It is to be hoped that the president's address may be printed in full. Two of the statements in it which impressed the writer most were: (1) the gaps which still exist in our knowledge of the marine algæ, especially in Floridian and Pacific waters, and (2) the algal desert which extends along our eastern coast from New Jersey to South Carolina. The state-

ments given in the abstracts were, for the most part, furnished by the authors of the papers, the writer having simply put the abstracts into a condensed and coördinate form, with here and there an addition from his own notes.

Prof. John W. Harshberger: *Some Morphological Structures in Paulownia imperialis.* — *Paulownia imperialis* is a Japanese tree of umbrageous habit which thrives well and suckers freely in the neighborhood of Philadelphia and farther south. Its method of branching is sympodial. The main shoot, or leader, is terminated by an inflorescence. After the fruit is formed, and the seeds are discharged, the axis of inflorescence dies back to the point where the lateral bud is given off which develops into the leader of the next season. Beneath this shoot two other branches are also formed, which in succeeding years branch in the same way as the leading shoot.

This tree flourishes in Japan in valleys and on the sides of hills exposed to the powerful action of the sun. A study of the leaf structure shows that the plant has adapted itself to that kind of environment, branched, antler-like, interlocking, protective hairs occurring on the lower foliar surface.

The flowers are arranged in clusters of cymes, which approach the scorpioid type. The flower buds are protected by five thick sepals, which are covered with ferruginous protective hairs. The flower parts inside of the young buds are all well formed. The pollen is fully formed, as likewise the pistil. In the mature pod, which splits to discharge the seeds in December, there is found a fleshy placental disk rich in tannin, which may be either a reserve product or a waste substance.

In the petioles of the foliage and sprout leaves a number of different shaped crystals are found. These are all calcium oxalate, the difference in form being due to the different metabolic influences existing at the time of their formation. Peculiar refractive granules, the nature of which is not fully determined, are also found in the mesophyll cells of the leaves.

Dr. W. F. Ganong: *On the Life History of Leuchtenbergia principis.* — This paper gave a synopsis of the author's studies upon the ontogeny of this rare and highly specialized species, the most noteworthy of the Cactaceæ. The paper traces the history of knowledge of the species, its systematic position, anatomy, morphology, etc. Its geographical distribution, habits and ecology, morphological composition as determined by comparative anatomy and ontogeny, and the

internal anatomy and its development are treated in full. This is intended by the author as the first of a series of life histories of important species of this family which are expected to yield data for a better understanding of principles of morphological modification under the influence of changing ecological factors.

This plant, which lives under arid conditions, represents the extreme of specialization along the Echinocactus line, as is clearly indicated by its embryology. It has a highly differentiated anatomy, the tracheid system being better developed than in any other plant known to the author. The mamillæ show three concentric rings of vascular bundles, a cortical ring, a ring leading to the spine system, and a central ring going to the flowers.

PROF. BYRON D. HALSTED: *Root Tubercules upon Spring and Autumn Grown Legumes.* — The ninth successive crop of wax beans upon the same plot (one-twentieth acre) grown in the spring of 1898 consisted of plants, the roots of which bore numerous large, nearly spherical tubercles. The plants of the succeeding crop grown in the summer upon the same soil had very few of the root galls.

The cause of this remarkable difference in the behavior of the same variety of leguminous plant in the same germ-laden soil must be ascribed to changes in soil conditions. During the early growth of the spring plants the soil was considerably cooler than in August, when the second crop was passing through the initial stages of development. There was, doubtless, aside from the different temperature of the soil, a wide difference in the amount of available soil nitrogen, it being much less in the comparatively cool earth of May than in the warmer ground of August.

The nitrifying germs of the soil, being more active in midsummer, provided a daily supply of combined nitrogen for the young growing plants. On the other hand, the spring crop, not having this ample supply was "nitrogen-hungry," and this furnished the proper condition upon the part of the host plant for the abundant development of the tubercles.

Successful inoculation of the plants with soil-extract or the pure culture of the tubercle germ "Nitragin" is dependent largely upon soil conditions, and many widely varying results may here find an explanation.

FRANCIS E. LLOYD: *Further Notes on the Comparative Embryology of the Rubiaceæ.* — The genera studied include Houstonia, Rubia, Sherardia, Vaillantia, Crucianella, Galium, and Asperula.

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PROF. JOHN W. HARSHBERGER: *Some Morphological Structures in Paulownia imperialis.* — *Paulownia imperialis* is a Japanese tree of umbrageous habit which thrives well and suckers freely in the neighborhood of Philadelphia and farther south. Its method of branching is sympodial. The main shoot, or leader, is terminated by an inflorescence. After the fruit is formed, and the seeds are discharged, the axis of inflorescence dies back to the point where the lateral bud is given off which develops into the leader of the next season. Beneath this shoot two other branches are also formed, which in succeeding years branch in the same way as the leading shoot.

This tree flourishes in Japan in valleys and on the sides of hills exposed to the powerful action of the sun. A study of the leaf structure shows that the plant has adapted itself to that kind of environment, branched, antler-like, interlocking, protective hairs occurring on the lower foliar surface.

The flowers are arranged in clusters of cymes, which approach the scorpioid type. The flower buds are protected by five thick sepals, which are covered with ferruginous protective hairs. The flower parts inside of the young buds are all well formed. The pollen is fully formed, as likewise the pistil. In the mature pod, which splits to discharge the seeds in December, there is found a fleshy placental disk rich in tannin, which may be either a reserve product or a waste substance.

In the petioles of the foliage and sprout leaves a number of different shaped crystals are found. These are all calcium oxalate, the difference in form being due to the different metabolic influences existing at the time of their formation. Peculiar refractive granules, the nature of which is not fully determined, are also found in the mesophyll cells of the leaves.

DR. W. F. GANONG: *On the Life History of Leuchtenbergia principis.* — This paper gave a synopsis of the author's studies upon the ontogeny of this rare and highly specialized species, the most noteworthy of the Cactaceæ. The paper traces the history of knowledge of the species, its systematic position, anatomy, morphology, etc. Its geographical distribution, habits and ecology, morphological composition as determined by comparative anatomy and ontogeny, and the

internal anatomy and its development are treated in full. This is intended by the author as the first of a series of life histories of important species of this family which are expected to yield data for a better understanding of principles of morphological modification under the influence of changing ecological factors.

This plant, which lives under arid conditions, represents the extreme of specialization along the Echinocactus line, as is clearly indicated by its embryology. It has a highly differentiated anatomy, the tracheid system being better developed than in any other plant known to the author. The mamillæ show three concentric rings of vascular bundles, a cortical ring, a ring leading to the spine system, and a central ring going to the flowers.

PROF. BYRON D. HALSTED: *Root Tubercules upon Spring and Autumn Grown Legumes.* — The ninth successive crop of wax beans upon the same plot (one-twentieth acre) grown in the spring of 1898 consisted of plants, the roots of which bore numerous large, nearly spherical tubercles. The plants of the succeeding crop grown in the summer upon the same soil had very few of the root galls.

The cause of this remarkable difference in the behavior of the same variety of leguminous plant in the same germ-laden soil must be ascribed to changes in soil conditions. During the early growth of the spring plants the soil was considerably cooler than in August, when the second crop was passing through the initial stages of development. There was, doubtless, aside from the different temperature of the soil, a wide difference in the amount of available soil nitrogen, it being much less in the comparatively cool earth of May than in the warmer ground of August.

The nitrifying germs of the soil, being more active in midsummer, provided a daily supply of combined nitrogen for the young growing plants. On the other hand, the spring crop, not having this ample supply was "nitrogen-hungry," and this furnished the proper condition upon the part of the host plant for the abundant development of the tubercles.

Successful inoculation of the plants with soil-extract or the pure culture of the tubercle germ "Nitragin" is dependent largely upon soil conditions, and many widely varying results may here find an explanation.

FRANCIS E. LLOYD: *Further Notes on the Comparative Embryology of the Rubiaceæ.* — The genera studied include Houstonia, Rubia, Sherardia, Vaillantia, Crucianella, Galium, and Asperula.

The Nucellus arises as a papilla, at the apex of which develop, in the hypoderm, about eight or ten macrospores which elongate, and many of which commonly germinate, reaching a quadri-nucleate condition. One (sometimes two) becomes the perfected embryo-sac, which in all forms studied has antipodals, a hitherto unrecognized fact (excepting in Houstonia). One of the antipodals is very large, comprising the whole lower half of the embryo-sac (Sherardia, Rubia, Galium). The condition in Asperula is not completely cleared up, but the material studied indicates that a larger number of antipodals are present, approaching in this respect certain Compositæ.

The pro-embryo has a suspensor which is divided into two regions, the micropylar and the embryonal. The latter is composed of disk-shaped cells; the former of large cells which are swollen out laterally, forming absorbing organs which become applied to the endosperm. A free preparation of these structures resembles a bunch of grapes, a condition similar to that described for Sutherlandia by Hofmeister and Guignard.

The integument becomes absorbed by the endosperm till only the outer layer of cells is left. The seed covering then consists of the pericarp and a single layer of cells derived from the integument.

CHARLES H. SHAW: *The Inflorescences and Flowers of Polygala polygama.* — In this plant the author has discovered a third set of inflorescences, namely, *green cleistogamic flowers, produced in late summer on geotropic aerial shoots.*

In the conspicuous pink-purple blossoms the style terminates in a dense hairy tuft, bearing the stigma as a lateral knob. The embryo sac is generally imperfect and the seed abortive.

In the underground cleistogamic flowers the wing-like sepals are reduced to the size of the other three, the two lateral petals are wanting, the stamens have decreased to six, five, four, three, or two, and the style and hairy tuft are reduced to the vanishing point, leaving the stigma closely sessile. On the other hand, they are more highly developed in at least two points, namely, the walls of the microspores are *exceedingly thick*, and the ovary is densely covered with *glandular hairs.*

The newly discovered aerial cleistogamic flowers furnish transition stages between these two sharply marked types. The style is better developed, and there are rudiments of the lateral petals. In the thickness of the microspore walls and in the structure of the pistil especially interesting connecting stages are found.

The cleistogamic flowers of both sorts produce more seeds than the conspicuous ones.

R. E. B. McKenney: *Observations on some Monocotyledonous Embryo-sacs.* — The development of two species of Scilla, *S. hyacinthoides* and *S. campanulata*, was described and reference made to the development of other Monocotyledonous Embryo-sacs. The archesporial cell is formed from a sub-epidermal cell. This cell grows rapidly and a small cell is cut off by a periclinal wall — the primary tapetal cell. The primary tapetal cell divides later by a periclinal wall, thus giving rise to an inner and an outer tapetal cell. The archesporial cell continues to grow and divides twice, giving rise to three cells. The upper one of these cells remains uni-nucleate, the lower becomes tetra-nucleate, and the middle one develops into the embryo-sac with its eight nuclei. It seems probable that each of the eight nuclei of the embryo-sac, as well as the four in the cell below, represents a macrospore. Hence, the embryo-sac may be considered as two sporocytes which never develop the separating wall. On this hypothesis, the cell above the embryo-sac and also the one below, each represents a sporocyte. Two cases in which such a partition in the embryo-sac has been observed were mentioned, one by Mann in Myosurus, and one by the writer in *Lilium candidum*. Especial attention was called to the extra-nuclear origin of the spindle fibres and to the entire absence of centrosomes. The author has slides made from *Lilium tigrinum* and *L. candidum*, which exactly confirm Mottier's statements as to the origin of the spindle in Lilium.

R. E. B. McKenney: *The Structure and Function of Crystal Cells in Sensitive Plants.* — The crystal cells in sensitive plants form a complete sheath around the bundle cylinder in stems and a half sheath around the bast of the leaf bundles. Each cell contains a single large crystal. These crystals usually have the shape of a hexagonal prism. Each one is imbedded in apparently homogeneous cytoplasm. The nucleus is very small and homogeneous, but a nucleolus is wanting. Sap vacuoles and starch are also absent. From tests made with hydrochloric acid, nitric acid, caustic potash, fluoric acid, etc., it seems probable that these crystals are very insoluble silicates. They are found in the ash after burning the plants. These silicate crystals are entirely wanting in the cotyledons and only make their appearance in the first leaf after it has been expanded for a day or two. The crystals are first found in the cells of the sheath at the

distal ends of the main bundles of the leaf as small spicular bodies. These gradually grow and assume the adult shape, but as they grow the nucleus becomes gradually smaller until it reaches its minimum size. Beginning with the cells at the distal end of the bundles, the crystals are developed in basipital fashion along the entire course of the bundle. The same course of development takes place in the bud leaves of old plants, only the crystals are fully formed before the leaf expands. These crystals were observed in several species of Mimosa, Acacia, and Oxalis. From the researches of Dutrochet and others it *seemed* as though the phloem was the region for the transmission of stimuli. However, since the crystal cells are closely applied against the phloem, and since they are best developed in the most sensitive plants and most poorly in least sensitive plants, it seems more probable that these cells constitute the *main* lines of transmission of stimuli. This tissue leads straight down to the pulvinus, but there are no crystals in the latter.

AMELIA C. SMITH: *Structure and Parasitism of Aphyllon uniflorum.* — The most conspicuous features of this plant are its parasitism on *Aster corymbosus* and the degradation attendant upon its parasitic habit as expressed by: (1) Absence of chlorophyll; degeneration of true leaves; loss of root hairs, and probably of root cap; reduction and degeneration of the bundle system, and relatively greater development of the phloem than of the xylem; small size of seed, and primitive embryo developed within a mass of tissue which is probably precocious endosperm. (2) Infrequence of stomata. Where present they are on the more exposed places, *i.e.*, outer surface of upper bract-leaves, upper part of flower stalks, and outer surface of calyx and corolla. (3) Abundance of starch. Starch is present in great quantities in root, stems, leaves, and carpellary tissue.

Sieve tubes seem to be entirely absent from the stem. The embryo is simply a mass of undifferentiated cells, *i.e.*, it is not distinguishable into cotyledons, plumule, and radicle. The use of the starch is problematic. The quantity stored in the endosperm is infinitesimal compared with that stored in other parts of the plant.

DR. M. A. HOWE: *On the Occurrence of Tubers in the Hepaticæ.* — The existence in this group of plants of tubers serving for vegetation propagation seems to have been, until very recently, almost unknown to plant morphologists. There are, however, four or five species, mostly of the genus Anthoceros, in which the occurrence of

tubers has long been known to systematists. This number has been recently increased until, at the present time, at least eleven species are known in which tuber-like growths occur. Of these, four belong to the genus Anthoceros, three to Riccia, two to Petalophyllum, one to Fossombronia, and one to Geothallus. It is to be expected that as the hepatic flora of the drier regions of the earth comes under more extended and accurate investigation, this evident adaptation for carrying the plant over a season of drought will be found to be much more common than has been generally supposed.

In the Californian *Anthoceros phymatodes* the tuber appears as a swelling near the apparent apex of the more or less well-defined costa of a Thallus-segment, becoming soon strictly ventral through the continued onward growth of the segment, and coming at the same time to be pendant from the ventral surface through the formation of a fleshy or slender and elongated peduncle. Tubers are globose or ellipsoidal in form, 0.25 to 1 mm. in diameter, at first smooth, but becoming at length thickly covered with root hairs. A cross-section of the body of the tuber shows it to consist of a cortex of 2 to 4 layers of nearly empty cells enclosing a central mass of smaller cells so densely filled with oil drops or with merely colorless granules that the cell boundaries in a section are rendered obscure. There is very little if any starch. In two cases, old tubers of *Anthoceros phymatodes* were found sending out new shoots, demonstrating that they play a part in the vegetative propagation of the plant. What had simply been inferred in regard to the function of these organs in the three tuber-bearing species of *Anthoceros* previously known has now been observed in this Californian species.

DR. HENRY KRAEMER: *Morphology of the Genus Viola.* — About 30 species of violets, chiefly from the United States, have been examined with special reference to style and stigma, stamen spur, size and shape of the pollen grains, hairs upon the stamens and petals, presence of bracts, mucilage cells, etc. The paper, which represents a large amount of painstaking work, was illustrated by many drawings, photographs, and photomicrographs.

Bracts with characteristic mucilage-secreting hairs occur in all of the species, and sub-epidermal mucilage cells are present in the leaf, stem, and all parts of the flower except the stamens.

A number of species agree in having a nearly globular stigma with a more or less well developed lip-like appendage, a style with a geniculate bend in the lower part, and corkscrew-shaped hairs on the

spurred petal. This group includes *Viola heterophylla*, *V. lutea*, *V. tricolor*, and varieties. In the remaining species the stigma is straight or somewhat globular and is destitute of any lip-like appendage, the style is bent or straight, and if any hairs are present upon the petals, they are straight. This group may be further subdivided on the length of the nectar-secreting stamenspur as follows:

(1) Spur shorter than the anther cells. — *V. blanda*, *V. primulæfolia*, *V. lanceolata*, *V. palustris*, *V. renifolia*.

(2) Spur of the same length as the anther cells and extending between them. — *V. rotundifolia*, *V. canadensis*, *V. nuttallii*, *V. hastata*, *V. pubescens*, *V. scabriuscula*, *V. tripartita*.

(3) Spur extending 1.5 to 1.8 mm. below the anther cells. — *V. pedata*, *V. ovata*.

(4) Spur extending 2.3 to 3.6 mm. below the anther.

- (*a*) Spur 0.78 mm. wide. — *V. arenaria*, *V. labradorica*, *V. striata*, *V. selkirkii*.
- (*b*) Spur 1.5 to 1.8 mm. wide. — *V. delphinifolia*, *V. odorata*, *V. obliqua*, *V. palmata*, *V. sagittata*, *V. sororia*.

(5) Spur extending 9 mm. below the anther. — *V. rostrata*.

Whether these 30 are all good species or partly varieties or hybrids is not yet certain. Color in some species has been shown to depend on climate, and the same is true of caulescence and acaulescence. The pollen is much alike in all. In some cases systematists appear to have mistaken germinating pollen grains for hairs in the bottom of the flower. The shape of the mucilage cells may possibly turn out to be of some help in classification. They are readily stained in a solution of methylene blue. The author would be glad to monograph this genus, if material could be obtained. He desires fresh seeds of Viola from all parts of the world. His address is Philadelphia College of Pharmacy, Philadelphia, Penn.

DR. G. E. STONE: *The Influence of Electricity upon Plants.* — Various kinds of currents were employed and data showing the relative effect of each upon the growth of the plant were presented, also the effect of single stimuli for a period of one minute, hourly intermittent and constant stimuli were shown. A brief *résumé* of some of the more important results obtained by subjecting about 20,000 plants to electrical stimuli are as follows:

(1) The application of certain strengths of current for a short period of time (one minute or less) is sufficient to act as a stimulus.

(2) The process of germination is accelerated by electricity.

(3) Electrical stimuli give rise to an acceleration in the growth of the plant.

(4) Electrically stimulated plants do not respond immediately to the influence of the current. The latent period following stimulation is equal to about 25 minutes, or, in other words, it is about the same as that for heliotropic and geotropic stimuli.

(5) The reaction of the plant to electrical stimulation is confined to a narrow range in the current intensity. The plant reaction is manifested either in an acceleration or retardation of its metabolic activities; the nature of the response depends entirely upon the nature of the strength of the current employed.

(6) There is a minimum, optimum, cessation, and maximum stimulus.

(7) The excitation produced by alternating currents is more marked than that produced by direct currents.

(8) The increase of stimulus necessary to produce an equally noticeable difference of perception bears a constant ratio to the total stimulus intensity; the relationship existing between the perception and stimulus is expressed by the ratio 1:3 (Weber's law).

Dr. C. O. Townsend: *Germination of Spores after Long Exposure to Distilled Water.* — Spores of Mucor, Penicillium, and other fungi were placed in test-tubes which had been partly filled with distilled water. Some of the test-tubes were placed in the open air so that the spores were subjected to the changes in temperature incident to the changes of weather from day to day as well as to the changes in temperature between day and night. Other test-tubes were kept at a nearly constant temperature of 18° in diffused light; others at the same temperature were kept in the dark, and still others at 25° in the light. The vitality of these spores was tested from time to time by placing them upon a gelatine-sugar mixture in damp chambers. So long as the spores, which were exposed to external conditions, did not freeze, they retained their ability to germinate in the usual time — from 12 to 16 hours. After they had been frozen, however, they did not germinate under the conditions used. The other spores under investigation retained their ability to germinate for about six months. The time required for germination after the spores were placed upon the gelatine-sugar mixture did not materially change during this period. It should also be noted that the growth of the mycelia, as well as the ability of the fungi to form new spores,

did not vary in any marked degree from the growth and spore development of dry spores.

DR. ERWIN F. SMITH: *Sensitiveness of Certain Parasites to the Acid Juices of the Host Plants.* — The author presented a tabular statement of the results obtained by inoculating acid nutrient solutions with bacteria parasitic to plants, *e.g.*, *Pseudomonas campestris*, *Ps. phaseoli*, *Ps. hyacinthi*, *Ps. stewarti*, *Bacillus amylovorus*, *B. oleæ*, etc. He was led to these studies by observing that the three yellow plant parasites first named spread very slowly through the parenchymatic tissues of their host plants. This is true in the field and in the greenhouse, and it also occurs when enormous numbers of the organism are injected into the parenchyma by means of hypodermic syringes. To fully realize the slow progress of these diseases they should be compared with such rapid diseases as pear blight, the brown rot of the potato, or the soft white rot of hyacinths, which often destroy large portions of the host in a few days. Two of these yellow organisms are vessel parasites, their entrance into the plant being favored by the alkaline juice of the ducts. In all three the restraining influence was believed to be, in great part, at least, the acid juice of the parenchyma. The detailed experiments confirm this view and show that there is a very wide difference in the susceptibility of bacteria to plant acids. All of the solutions were titrated with $\frac{N}{10}$ NaOH and phenolphthalein, so that their exact acidity is known. Those who wish details are referred to a forthcoming bulletin on the pathogenic properties and life history of *Ps. hyacinthi*, of which this paper will form a part.

DR. CARLETON C. CURTIS: *Further Observations on the Relations of Turgor to Growth.* — Experiments were undertaken to determine (1) how soon growth would be renewed after a change in the concentration of the nourishing solution, and (2) to measure the turgor force at the moment of renewed growth. Three species of fungi were used — a Penicillium, a Mucor, and a Botrytis. These plants were grown in nourishing solutions and in the same with addition of 4, 9, 14, and 20 per cent nitrate of potash. Penicillium grown in the nourishing solution had a turgor force of 7.5, nitrate of soda being used as a plasmolyzer; when grown in 20 per cent nitrate of potash, it had a turgor force of 42.5. When transferred from the nourishing solution to the 20 per cent solution, growth was stopped from 8 to 12 hours. At renewal of growth the turgor was found to be normal for the 20

per cent solution, *i.e.*, 42.5. In changing from 20 per cent to 0, solution growth ceased, to be renewed again in 30 to 45 minutes. On this renewal of growth the turgor force was found to be normal for the 0 solution, *i.e.*, 7.5. Corresponding results were obtained with the weaker solutions. Thus, in changing from 0 to 4 per cent, recovery was effected in about 1 hour, the turgor force being 12, *i.e.*, normal for hyphæ growing in such a solution. In changing from 4 to 0, growth was renewed after about 15 minutes. Botrytis gave practically the same results. Mucor was much more sensitive. It has a lower turgor force and would not stand a change higher than a 4 per cent solution. In other respects it behaved like Penicillium and Botrytis. When nitrate of potash is used, turgor would seem to be a controlling force in growth. The checking of growth when the turgor is increased, as by change from a strong to a weak solution, corresponds to injury from cutting, *i.e.*, is in the nature of a shock, the length of time growth is inhibited depending on its severity.

DR. W. F. GANONG: *Some Appliances for the Elementary Study of Plant Physiology.* — The author pointed out that investigation is indirectly aided by good elementary teaching, which diffuses its results and enlists sympathy and support, and as well attracts more and better students for the making of investigators. At the present time, too, there is a rapidly increasing tendency to introduce more physiological study into elementary courses in schools and colleges, which is producing a demand for simpler and less expensive physiological appliances. In elementary teaching it is qualitative results that are mainly sought, and hence much simpler and less exact appliances can be used than is possible in investigation where nothing less than the very best can profitably be employed. The author then exhibited and described some simple appliances developed in his physiological practicum in Smith College. These included a simple temperature stage, made of copper; an efficient clinostat ample for demonstrating the principles of geotropism, heliotropism, etc., constructed from clockwork; a simple and inexpensive self-recording Auxanometer; an Osmometer made from burettes and Schleicher and Schuell's diffusion shells; a very simple apparatus for demonstrating the exchange of gases in respiration; a special germination box; an advantageous method of preparing a potted plant for the study of transpiration, and a simple method of graduating roots, etc., with insoluble India ink, which is applied on a stretched thread along which it runs by capillarity.

PROF. D. T. MAC DOUGAL: *Symbiosis and Saprophytism.* — It is customary to designate all chlorophylless, seed-forming plants, which have no nutritive connection with other vascular species, as saprophytes, or more exactly as holosaprophytes (allotropic or heterotropic forms, according to Pfeffer's classification), and others of similar physiological tendencies as hemisaprophytes (mixotropic forms), without regard to the nutritive unions formed by the roots or absorbing organs, as in mycorhiza, tubercles, and other associations. It is obvious that the terms *saprophyte* and *holosaprophyte* should be applied to those species only which derive their food supply from organic products directly without the activity of chlorophyll and unaided by other organisms. In this sense, which appears to be the only meaning admissible, the holosaprophytes include numerous bacteria and fungi, but, so far as previous investigations show, only one seed-forming genus, Wullschlægelia. As the result of some work now in press, the waxy white orchid of the northwest, *Cephalanthera oregana* Reichenb., should be added to this category.

As a consequence of the acceptance of the limitation of the term holosaprophyte, as given above, all those species furnished with mycorhiza or tubercles, or which enter into direct mechanical or nutritive associations, must be classed as symbionts.

It is a matter of common knowledge that seedlings are holosaprophytic in the stage in which they are wholly dependent upon the reserve material in the endosperm, and, in general, during the period previous to the formation of chlorophyll. This period is practically obliterated in those species in which chlorophyll is formed in the seed. The capacity for the absorption of humus products has played an important part in the production of the minute seeds of the orchids and other groups of similar physiological organization, and the extension or retention of this capacity throughout a greater or less portion of the life of the sporophyte has resulted in varying stages of true saprophytism. Although, so far as known, this period has been extended to include the complete life history of this generation in only two seed-forming genera, the results of recent investigations show that practically all green plants are capable of taking up and using a varying proportion of humus products. Only those which show a marked extension of this capacity should be classed as hemisaprophytes. The hemisaprophytes among seed-forming plants would therefore consist chiefly of carnivorous species, whereas nearly all of those now included are, in fact, more or less symbiotic by means of mycorhiza, tubercles, etc.

PROF. D. T. MAC DOUGAL: *Influence of Inversions of Temperature and Vertical Air Currents upon the Distribution of Plants.* — The soil and the air resting upon it receive the same amount of heat during the day, but at sunset the temperature of the earth is slightly higher than that of the air. At this time both begin to lose heat, but the soil cools much more rapidly than the air. The air is a poorer conductor than the soil, and hence the layers of air resting immediately upon it are cooled by radiation and conduction to the cold surface to a temperature far below that of the body of the air a few meters above. The consequences of this inversion are to be seen in the effects of late spring frosts, when the lower branches of a tree or shrub may be injured while the upper ones will be unharmed.

This nocturnal inversion of temperature occurs over almost all land areas, but is most marked in regions of low relative humidity. In North America it is most pronounced on the elevated plains, where it is a distinct but heretofore unrecognized factor in determining the boundaries of life zones.

In broken countries the cooling of the surface layers of air results in its contraction and increase in weight, and, as a consequence, the cold air thus formed on elevated mesas, ridges, and hilltops flows down the slopes into the depressions and valleys, filling the latter with a deep layer of cooled air while a constant supply of warm air settles down on the highlands. As a result of this action, the hills and lower mountain ridges have a much more equable temperature than the valleys and cañons. Thermographic records obtained at Flagstaff, Arizona (in a valley 6862 feet above sea level), and on Observatory hill (on the west side of the valley at an elevation of 7162 feet), in June and July, 1893, show that the minimum temperature of the valley was 15° to 27° F. lower than that of the hill at the same time.

If the slopes of the hill or mountain are several thousand feet in vertical extension, the descending current may sweep down so rapidly as to actually increase in temperature and reach the valley below as a warm wind. Regular currents of this sort are rare. The "Chinook" or "Foehn" owes its warmth to this cause.

Again, the upward movement of the air, under the influence of the sun's rays during the day, results in an expansion and absorption of some of the heat, so that these currents reach the highlands at a lower temperature than the air resting on such areas, and tend to an equalization of the temperature. At the stations mentioned, the maximum temperature of the hill was always 4° to 6° F. below that

of the valley. Thus the total daily variation on the hill was 20° to 30° F. less than that of the valley.

Now, the northern advance of southern plants is governed by the sum of the positive temperatures, or the sum of the temperatures, above that at which plants and animals start into activity in the spring, taken throughout the entire season of growth and reproduction; and the southward distribution of northern plants is governed by the mean temperature of a brief period of a few weeks during the hottest part of the summer. It is obvious, therefore, that, as the positive temperature of the hills and mesas is greater than that of the valleys, the southern plants should find their way farthest north along the minor ridges and hills. At the same time the average temperature of the valleys is lower than that of the ridges, and hence the northern flora should reach its southernmost limits down valleys heading up in mountains and mesas favorable to the development of the greatest effects of inversions of temperature.

The influence of inversions of temperature is, therefore, to make extremely sharp deflections of the zonal boundaries, which may extend only a short distance locally, or which may reach over a hundred kilometers from the general limits of the zone. This conclusion is supported by my own observations in Arizona, and by facts concerning the flora and fauna of New Mexico and Texas cited by Professor Townsend.

Ascending currents of air also cause changes in humidity which exercise an extremely local influence on the distribution of the moisture-loving forms. As the diurnal warm current ascends the slope of a hill or the walls of a cañon, it expands and loses heat, and at the same time the dew point is lowered or the relative humidity is increased. When the current reaches the level of the highland it flows over it as a moist and cool wind. It is gradually warmed again, however, and its dew point raised in a few kilometers, progress. As a result of this action the area bordering upon a cañon, gulch, or valley offers a much more humid atmosphere than regions more removed, and hence these portions are most suitable for the moisture-loving species.

This principle is beautifully illustrated by the distribution of *Razoumofskya vaginata* (Willd.) Kuntze, which is parasitic on *Pinus ponderosa* var. *scopulorum* in this region. Although native of a semi-arid region, the parasite is most successful in the germination of its seeds and the attachment of the seedlings to the host plant in a humid atmosphere. While it is found throughout the pine belt, it is most

abundant along the margin of mesas, and along hills bearing a certain topographic relation to adjoining valleys. The most striking example of this fact is to be seen along the mile-deep cañon of the Colorado river. Here the heated air rising from the river bed, under the rays of a sub-tropical sun, loses 20° F. of heat in its vertical ascent of over a kilometer. As a consequence it pours over the rim of the mesa heavily laden with moisture, and the Razoumofskya is quite abundant in a belt a kilometer in width running parallel to the rim, while it is comparatively infrequent at greater distances from the cañon.

PROF. CONWAY MAC MILLAN: *Notes on the Reproduction and Development of Nereocystis.* — The author described the great bladder kelp, *N. Lütkeana*, which is abundant in the swift tide-water channels of Puget sound, and which frequently reaches the enormous length of 80 to 100 meters. He has studied several hundred specimens (collected by Miss Josephine Tilden) with special reference to structure and early stages of growth. He exhibited a plant less than 1 millimeter long, and also one about 10 meters long. The latter consisted of a hollow green stem several centimeters in diameter at the base where it was anchored to the mud or rocks by a mat of large branched rhizoids, about 2 decimeters broad. This green stem gradually enlarged, until, at a distance of about 3 meters from the rhizoids, it very gradually expanded into a bulb 8 or 10 centimeters in diameter. This was crowned by the broad, thin, and very long, floating green laminæ. The figure given in *Die Natürlichen Pflanzenfamilien* is not a very good one. At low tide the sea is dotted with these floating bulbs, and the plants are so strong, in mass, that fishing boats may be anchored to them, while smaller boats are sometimes capsized by them. As is well known, the Aleuts formerly used the flexible hollow stem to siphon water from their boats.

Spores in sporangia are the only known reproductive bodies. Calosities occur on old plants. Sieve tubes are present. They are pulled out by the elongation of the stem, and are undoubtedly converted into gelatin. They are morphologically different from trumpet hyphæ. No evidence of protoplasmic connections was obtained. The cryptostomata disappear on old plants. The cleft in the lamina arises not as a tear, but is started by the deliquescence of a single row of cortex cells just below the epidermis. As the result of this continued deliquescence an ever deepening fold arises which finally cuts the lamina into two. Many slides, specimens, photographs, and drawings were exhibited.

DR. E. A. BURT: *The Formation and Structure of the Dissepiment of Porothelium.* — The author traced the development of the fructifications of *Porothelium fimbriatum* Pers. from their origin as papillæ, through the pore, to the tube stage, in the latter stage contrasting the structure of the dissepiment where the tubes are closely crowded together with its structure where they are more scattered.

This fungus occurs as a thin, closely adhering layer on dead limbs, etc. The papillæ are solid throughout their early history. They develop into pores by the more rapid growth of some parts than of others. In some species, as *P. friesii*, the papillæ are buried; in others, regarded as higher in rank, the papillæ are buried only in early stages of growth.

DR. ERWIN F. SMITH: *Gelatin Culture Media.* — By means of a chart, photographs, and paintings the author called attention to the diverse and confusing results different individuals working with the same organism might reach with gelatin culture media. Our knowledge of this very useful medium has increased greatly in recent years. The best paper in English is by Geo. S. Fuller, "On the Proper Reaction of Nutrient Media for Bacterial Cultivation," *Journal of the Am. Public Health Association*, October, 1895, Concord, N. H. The most confusing things are: (1) the fact that gelatin which reacts neutral or moderately alkaline to litmus is still acid to phenolphthalein and often exerts a restraining influence on bacteria, especially certain parasites; and (2) the fact that grape sugar or cane sugar in gelatin, while stimulating growth, often entirely prevents liquefaction, so that one may be dealing with a liquefying organism without knowing it. Some liquefiers are more sensitive than others, and it is not yet known how small an amount of sugar will restrain the most sensitive forms.

All gelatin media should be rendered neutral to phenolphthalein, and it would be well, for the present at least, to use beef broth free from muscle sugar in making gelatin. Possibly the restraining influence of sugar may also be of some use in making gelatin plate cultures of slow-growing forms which are mixed with rapid liquefiers, and which under ordinary circumstances run over and spoil the plate before the desired form has been able to grow.

All gelatin media should be titrated against $\frac{1}{10}$ or $\frac{1}{20}$ normal caustic soda, and then the desired amount of acid or alkali added in the form of double normal solutions so as not to much disturb the proportion of fluids and solids. The melting point depends on the amount of gelatin added, the length of the steamings, and the amount

of acid or alkali added. All of these disturbing influences should be taken into account. The per cent of gelatin used and the melting point of the prepared media should always be stated.

Working with gelatin of varying grades of acidity and alkalinity, prepared according to Fuller's scale, *e.g.*, with + 50 + 40 + 30 + 20 + 10. 0 — 10 — 20 — 30 — 40 — 50, with interpolations and extension of the scale, if necessary, it is possible to obtain curves of growth decidedly different for different species, even those which are morphologically much alike and which behave the same on nutrient agar. On this scale the + signs indicate acidity and the — signs alkalinity, and the figures denote, per liter of nutrient gelatin, the number of cubic centimeters of the normal acid or alkali which would have to be added to render the medium exactly neutral to phenolphthalein. The litmus neutral point of gelatin is approximately + 25 of this scale. The varying behavior of *Pseudomonas campestris* in the same gelatin with different quantities of caustic soda is shown on the accompanying plate.

PROF. CHARLES E. BESSEY: *Relative Infrequence of Fungi upon the Trans-Missouri Plains and the Adjacent Foothills of the Rocky Mountain Region.* — A study of the fungus flora of the Trans-Missouri Plains, extending over a period of fourteen years, has shown that while the number of species is large the number of individuals is relatively small. This is in marked contrast to the flowering plants, where the number of individuals is relatively high as compared with the number of species, especially in the herbaceous groups.

Of the principal groups of fungi, the Phycomycetes are usually quite infrequent, appearing in considerable numbers in wet years only; the Perisporiaceæ are, likewise, not usually abundant, although occasionally becoming very abundant, as with the Phycomycetes; the Pyrenomyceteæ are numerous as to species, but ordinarily infrequent as to individuals, with, however, some marked exceptions, as the ergot of Agropyron and Elymus (*Claviceps* spp.); the Discomyceteæ are rare, excepting in the most favorable of seasons; the Uredineæ are usually abundant, although the number of species is not exceptionally large; the Ustilagineæ are not numerous in species nor commonly abundant in individuals, excepting for three or four which affect the cultivated cereals; of the "Fungi Imperfecti" the number of species is relatively large, while again the individuals are relatively infrequent.

The higher fungi, including the Basidiomyceteæ, show this infrequence of individuals still more emphatically; the Gasteromyceteæ are ordinarily infrequent, with now and then an exception, in favorable periods, as when *Ithyphallus impudicus* springs up in great abundance; the Hymenomyceteæ are normally rare, although the number of species is fairly large.

Apparently this relative infrequence of the fungi is due to the greater aridity of soil and air, resulting in less favorable conditions for the germination of the spores, as well as for the subsequent development of the plants themselves.

B. M. Duggar and F. C. Stewart: *Different Types of Plant Diseases due to a Common Rhizoctonia.* — Rhizoctonia was established by De Candolle, in 1815, as a generic name for certain sterile fungi. Many species have since been described, all of which may be subterranean parasites. There is no certain evidence connecting these forms with fruiting stages. Studies in plant diseases during the past few years have brought together some very different types of disease due to Rhizoctonia, viz.: (1) damping off of seedlings of many kinds; (2) a rot of radishes; (3) a root-rot of beets; and (4) a stem-rot of carnations. Experiments have proved conclusively that the root-rot of the beet and the stem-rot of the carnation are interchangeable, and indicate that the sterile damping off fungus is also very probably the same species slightly modified physiologically. Under certain conditions Rhizoctonia forms sclerotia on the host (carnation) and also on culture media. On the beet brown mycelia but no sclerotia develop. The mycelium is peculiar in its method of branching, and in the formation of certain hyphal elements which function as spores. The germ tubes of these nearly iso-diametric elements often bore through the septa of empty cells to which the germinative cells are still attached. The fungus grows well in acid media, but is very sensitive to alkaline media, and this suggests methods of treatment, *i.e.*, by liming the soil. The similarity of all of the forms studied suggests that some other so-called species may likewise prove to be the same organism, and at present the plant cannot be referred to a definite species.

F. C. Stewart: *The Stem-Rot Diseases of the Carnation.* — Under the name "stem-rot" or "die back" at least two distinct diseases have been confused. One is caused by Rhizoctonia; the other is due to a Fusarium and is, perhaps, identical with Sturgis's carnation

stem-rot. Both diseases are common in New York in the field and in the greenhouse.

The Fusarium attacks chiefly the stem and larger branches, discoloring the wood and killing the cortex. The stems rarely become soft rotten. The plants die gradually, with yellowing and drying of the foliage. The fungus fruits rarely on the outside of stems, but more frequently in the cambium and medulla of stems long dead.

The Rhizoctonia causes plants to wilt suddenly by rotting the stem at, or just below, the surface of the soil. The cortex readily separates from the wood. The medulla is attacked quite early, becoming water-soaked in appearance (or corky, when dry) and filled with hyphæ.

THE OSSICULA AUDITUS AND MAMMALIAN ANCESTRY.

J. S. KINGSLEY AND W. H. RUDDICK.

The various students who have investigated the mammalian ear-bones have arrived at the most diverse views as to their homologies, and it was with the idea of satisfying ourselves which of the several accounts of these structures was correct that we began our studies. As we progressed, however, it became apparent that these ossicles threw no little light upon the broader question of the origin of the mammalia. In our final paper we will give full details of all of our observations, as well as a discussion of the results of other students. The present paper states our views of the homologies of these ossicles in a brief manner and shows the bearings which these have upon the problem of mammalian descent. The material which we have studied has been embryos and larvæ of Amphiuma, Pipa, Ichthyophis, Sceleporus, rat, and pig, and our methods have been largely those of wax reconstruction from sections.

Distinct auditory ossicles occur in no fish-like form, but from urodeles to man, in one shape or another, they are present in all forms. In urodeles there is a large fenestra ovalis in the outer wall of the otic capsule, and in this, connected to its margin by membrane, is a cartilaginous plate which is usually called the stapes. It is unnecessary for our present purpose to consider whether this element is formed from the otic capsule, or is the homologue of the hyomandibular of the fishes, or, again, is an independent structure. In most urodeles this stapes is attached to other structures by ligaments alone, but in Amphiuma as well as in Plethodon (*teste* Winslow) and in all Cæcilians which have been studied, the stapes articulates directly with a stapedial process which is given off from the posterior side of the quadrate. At first this quadrate is free from the cranium, and is connected only with the slender Meckelian car-

tilage of the lower jaw. A little later the quadrate extends to and fuses with the otic capsule a little above and in front of the fenestra ovalis. This we may term the urodele type of auditory ossicles, although it is a question as to how far they serve as a sound-transmitting apparatus, the tympanum being entirely absent in the urodeles. These features, then, are the possession of a quadrate which acts as a suspensor of Meckel's cartilage, and at the same time articulates with the stapes. It may be noted, in passing, that in the Cæcilians the stapes is perforated, much as in mammals, for the passage of the stapedial artery, a feature which adds to the probability that this element is homologous throughout the pentadactyle vertebrates.[1]

Of the anura we have studied Pipa, and our results here are much like those of Gaupp upon Rana. In both of these genera the essential features from our present standpoint show no affinities with the urodeles, but resemble rather those of the sauropsida, and hence a description of the relations in a lizard will answer present purposes.

In Sceleporus, which we take as the sauropsidan type, and in which we have studied several stages of the conducting apparatus, the auditory chain consists of a stapes lying in a fenestra ovalis, and, connected with this, a columella consisting of at first a cartilage rod extending horizontally outward into the tympanic membrane. When first differentiated, the shaft of this columella lies in the mesenchyma posterior to the entodermal diverticulum, the distal end of which expands later to form the tympanic cavity. In other words, *the columella is postspiracular.* Another point of considerable importance, and one which has been neglected by most previous students of the auditory ossicles, is the relation of the stapedo-columellar tract to the adjacent nerves. The facial nerve, after leaving the cranium, passes backward just outside the otic capsule, running above the stapedo-columellar shaft. At the most posterior point of its excursion the facialis gives off a nerve, the chorda

[1] In spite of this similarity between the auditory chains of Cæcilians and Amphiuma, we do not agree with Cope that the Cæcilians have descended from Amphiuma, nor with the view of the Sarasins that Amphiuma is a neotænic gymnophione. The senior author hopes to present his views upon these points at an early date.

tympani, which runs forward *above* the shaft of the columella and on the medial side of the quadrate, to extend into the lower jaw, together with the mandibular branch of the trigeminal nerve. With further development the columella seemingly invades the tympanic cavity. In reality the cavity in its expansion extends around the rod, which, however, remains connected with the posterior tympanic wall by means of a fold of the tympanic epithelium and the enclosed mesenchyma. The quadrate, contrary to what obtains in the urodeles, does not articulate with the stapes, nor is it connected, except by liga-

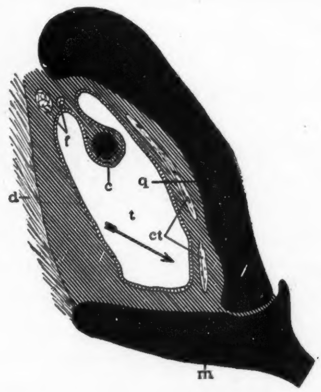


FIG. 1. — Section through the tympanic region of an embryo of *Sceleporus undulatus*, showing the columella, *c*, entering the tympanic cavity from behind; the arrow points towards the tip of the snout, the cartilages are black. *d*, digastric muscle; *ct*, chorda tympani; *f*, facial nerve; *m*, head of Meckel's cartilage; *q*, quadrate; *t*, tympanic cavity.

ment, with the sound-conducting apparatus. Its sole function is that of a suspensor of the lower jaw. The sauropsidan type, then, may be characterized as consisting of a stapes and a columella which form the auditory chain, the columellar shaft being post-trematic in origin, while the quadrate is outside of and apart from the sound-conducting apparatus.

All other questions regarding this apparatus in the sauropsida must be ignored here — the question of the homologies of the stapes, the relations of both stapes and columella to the hyoid and hyomandibular, etc., as well as discussions of muscles; we can only call attention to the fact that there is some

evidence to show that that portion of the columella which lies within the tympanic membrane may possibly be homologous with the manubrium of the mammalian malleus, to be described below.

In speaking of the auditory ossicles of the mammals, it will be necessary to go into more detail, since, while the different features of development have been described several times, there is great diversity of opinion as to the homologies of the parts concerned.

In the pig the ossicula auditus and related parts can first be made out in embryos measuring about eighteen millimeters in

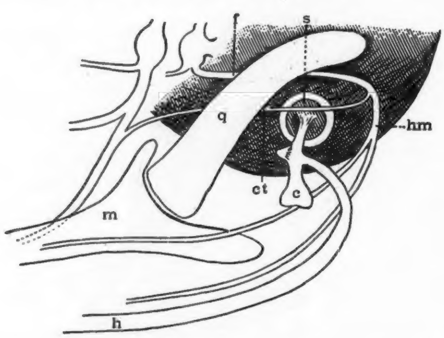


FIG. 2.—Diagram of otic region in Sceleporus embryo: *c*, columella; *ct*, chorda tympani; *f*, facial nerve; *h*, hyoid; *hm*, hyomandibular nerve; *m*, head of Meckel's cartilage; *q*, quadrate; *s*, stapes in foramen orale; the otic capsule shaded.

total length, and sagittal sections give the clearest pictures. In embryos of this size the otic capsule has not begun to differentiate, the utriculus, sacculus, and semicircular canals being imbedded in a homogeneous matrix of mesenchyme, which nowhere shows that concentration of nuclei so characteristic of procartilage formation. The stapes, on the other hand, is well outlined as a mass of procartilage formed around the stapedial artery, the mass having the form of a ring rather than the stirrup shape of the adult. Ventral to the stapes is the Eustachian cleft, which as yet shows no differentiation into tympanic cavity and tube. This cleft extends outward for some distance above and parallel to the inner end of the external

meatus. The tissue between these two tubes is to form the tympanic membrane, its plane being now nearly horizontal instead of oblique, as in the adult. In this membrane is formed a rod of procartilage entirely unconnected with any other skeletal structure, the Anlage of the manubrium mallei. In front this procartilage gradually shades off into the looser mesenchyme between it and the mandibular arch, while behind it is very sharply delimited from the undifferentiated tissue lying between it and the hyoid.

In front of the Eustachian cleft and external meatus is another mass of procartilage, the anlage of the mandibular arch. At first it consists of a continuous stroma, which extends proximally and dorsally to a point just in front of the stapes, distally into the lower jaw. This procartilage rod is not equally dense throughout, but at the level of the future tympanic membrane the nuclei are less crowded than they are above and below. This indicates a division which later becomes more marked, separating a proximal element, the incus, from a more distal portion which will give rise later to a proximal body of the malleus and its processus longus and a more distal rod of cartilage which extends into the lower jaw. So far, with the exception of the separate origin of the manubrium of the malleus, all who have approached the problem of the mammalian ear-bones from the developmental standpoint are in agreement. The differences of opinion are regarding the nature of the incudal element.

In the pig embryo, twenty millimeters long, several changes have been introduced. Chondrification of the otic capsule is well advanced, the foramen ovalis being formed around the base of the stapes in such a way that it lies within the opening. In the stapes itself the process of chondrification has set in, while outside the junction of its crura arises a short process which articulates with a stapedial process of the incus. The body of the incus is now an elongate plate with rounded extremities, the whole occupying a vertical position. The dorsal end extends up to, and may be said to articulate with a depression in the outer wall of the otic capsule, just above and outside the foramen ovale. Below, the stapes also articulates with the body of the malleus. The stapedial process of the incus is a slender

rod, smaller than the body, which extends backwards and slightly downwards to the stapes. From the body of the malleus a strand of cartilage has extended backwards and has fused with the manubrial cartilage noticed above, the whole forming the manubrium of the adult. Distally, the mallear cartilage is still continuous with the rest of Meckel's cartilage, extending into the lower jaw.

At this stage we can recognize clearly the three[1] ossicles and their processes of the adult ear. So far they all lie outside of, and, so far as incus and body of the malleus are concerned, in front of the tympanum; they are prespiracular. Hence it follows, as certainly as any morphological conclusion can be drawn, that they cannot be homologized with the columella and its derivatives in the sauropsida, as has been attempted by Albrecht, Dollo, and others. This lack of homology is still further emphasized by the course of the chorda tympani, which in its course passes *below* the articulation of incus and stapes, and then forward on the inner or medial side of the incus to the fifth nerve. It may, however, be possible that the manubrial portion of the malleus is homologous with the distal portion of the columella.

The question now comes up for decision, What are the homologues of incus and malleus in the lower vertebrates? All recent students are in agreement that the body of the malleus is derived from Meckel's cartilage, for it retains its connection with the cartilage of the lower jaw for some time; but whether it is the articulare of non-mammalian groups can only be decided later, after a discussion of the incus. Concerning this latter bone two views are held at present, for no recent student has attempted to recognize in it the hyomandibular. According to one view the incus is the quadrate, while according to the other it arises from the proximal end of Meckel's cartilage, while the quadrate, according to this same view, has fused with or has become lost in the squamosal region of the mammalian skull.

The greatest objection which has been advanced to the first

[1] The os-obiculare or lentiforme occurring between the incus and stapes is a later structure without morphological significance.

of these homologies — the incus-quadrate homology — is that it must necessarily follow that the articulation of the lower jaw with the cranium in the mammals cannot be homologous with the articulation in the lower vertebrates, and that it is difficult to imagine this transfer of functions from one point to another. The weight of this objection we admit, but we shall endeavor to show a little later that no matter what view one takes of the fate of the quadrate in the mammals, there is this same problem of the formation of a new articulation to be met, for it is impossible, upon any basis, to homologize the articulation of the lower jaw in the mammals and the non-mammalian groups.

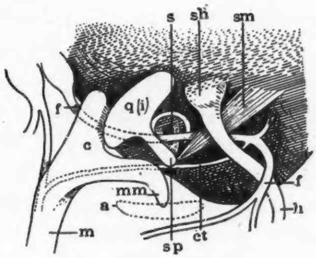


FIG. 3. — Diagram of otic region in pig embryo: *a*, position of external meatus; *c*, body of malleus; *ct*, chorda tympani; *f*, facial nerve; *h*, hyoid; *m*, Meckel's cartilage (processus longus); *mm*, manubrium mallei; *q* (*i*), quadrate (incus); *s*, stapes; *sh*, styloid process of hyoid; *sm*, stapedial muscle; *sp*, stapedial process of quadrate.

In all ichthyopsida and sauropsida the articulation of the lower jaw with the cranium is in reality an articulation between the quadrate and Meckel's cartilage, and even when it becomes an osseous articulation it is an ossification of the cartilages which affords the articular surfaces. In the mammals, on the other hand, Meckel's cartilage does not approach in any way to the glenoid fossa. The mandible forms around the distal portion of Meckel's cartilage as a membrane bone, and its ascending ramus grows away from the cartilage towards the glenoid fossa. So it is evident that the mandibular part of the articulation in the mammals is not formed by the Meckel's cartilage. How about the fusion of the quadrate in the squamosal, as maintained by Peters, Albrecht, and Cope? Development shows us not the slightest trace of cartilage in the region of the squamosal;

there is nothing but membrane bone. Besides, the proper position for the quadrate is at the proximal end of Meckel's cartilage. But Meckel's cartilage extends far back of the glenoid fossa, and one cannot readily imagine any reason for the transfer of the quadrate from one position to another. In a word, it is as incumbent upon those who claim that the quadrate has been lost in the squamosal region as upon those who recognize the quadrate in the incus, to explain the formation of a new articulation in the mammals.

An easily accessible figure will illustrate these points: Fig. 254 on p. 467 of Bell's translation of Gegenbaur's *Comparative Anatomy*. If the articulation of the lower jaw of mammals be homologous with that of lower vertebrates, then Meckel's cartilage (*p*) should run up into the glenoid fossa. If the incus (*i*) be the proximal end of Meckel's cartilage, then the quadrate should be sought between it and the cranial wall immediately adjacent. It is difficult to imagine how the quadrate could be translated from the point crossed by the "leader" from *i* to a point in the glenoid fossa crossed by the "leader" from *p*.

If, on the other hand, we suppose that the proximal end of Meckel's cartilage be represented by the body of the malleus, then the incus is in just the proper position for the quadrate; and the proportionally large size of this element in its earlier stages shows that it must have been of large size in the ancestral form. Then, again, in the embryo this incus acts as a true suspensorium of the lower jaw, while its connection with the stapes is of secondary size. In short, it fulfills every condition demanded of a quadrate in position and relation to other parts, and we doubt if its nature would have been questioned were it not for the hypothesis that the mammals had descended from the theromorphs in which the squamosal as well as the quadrate enters into the formation of the articular surface for the lower jaw.

One objection to the view that the incus is the quadrate is based upon the fact that it does not appear from the first as a discrete element, but is differentiated from a continuous stroma. This objection loses much of its force when we consider that

both Meckel's cartilage and the palatoquadrate of the elasmobranchs arise from a continuous cord of cells, and only with the process of chondrification does differentiation occur. In the digits the separate phalanges are likewise developed from a continuous mass of procartilage cells. In the light of all the evidence we feel impelled to agree with the majority of the embryological students who have studied the question and to regard the incus as the quadrate.

It appears to us that the relations of these ear-bones throw no little light upon the question of the origin of the mammals, or at least of the so-called higher mammals, since it is not beyond question that the mammals are a monophyletic group. For many years it was the general supposition that the mammals have descended from the Amphibia. Then came the discovery of the meroblastic ova of the monotremes, and the almost simultaneous announcement of the recognition of mammalian features in the theromorphous reptiles. Then for several years the prevailing view was that the mammals must have had a reptilian ancestry; but the pendulum began to swing backwards. The difficulty of the double occipital condyle remained. Hubrecht has pointed out the difficulty of deriving the mammalian ovum, with its peculiarities of segmentation, gastrulation, and especially its fœtal envelopes, from the sauropsidan type, while these can readily be evolved from the amphibian egg. Maurer has shown that it is impossible to compare the hair, so characteristic of mammals, with any known structure in reptiles; while, on the other hand, he has pointed out the close resemblances even in structural details between hair and the epidermal sense organs of the Amphibia.

Now, when we consider the ossicula auditus we see the impossibility of deriving those of the mammals from those of the reptiles. As we have shown, the shaft of the columella in the reptiles is postspiracular and is below the chorda tympani, while the incus and the body of the malleus are prespiracular and are above and outside of the chorda tympani. On the other hand, the mammalian ear-bones with all their peculiar features (the manubrium of the malleus excepted) are derivable from those of some urodele-like form. In the urodeles, as in mam-

mals, we find an articulation of stapes with quadrate, while in the reptiles no such articulation occurs.

Another fact which has a bearing upon the question of the origin of the mammalia has not, so far as we are aware, been referred to. In the urodeles[1] there develop a pair of thoracic ducts, one duct emptying into the venous system on the right side, the other into the left, near the heart. Of these ducts, the left is from the first the larger, while a little later the right completely disappears, leaving the left as the functional duct of the adult. This disparity in size from the first would show that this left-sided condition had persisted for a long time. In the mammals, as is well known, the left thoracic duct alone is functional, while in all sauropsida it is the right that persists. It is, therefore, impossible to derive the mammalian conditions from those found in any existing reptile, but of course one cannot say but what the earlier reptiles had this part of the lymphatic system paired. However, the conditions in the urodeles are suggestive.

We would not be understood to derive the mammals from any true urodele stock, but from some ancestor not widely removed from them. The urodeles, as we know them to-day, are a degenerate group, possibly descendants from terrestrial forms, and the lowest of the group, like Necturus, etc., have departed most widely from the ancestral type. The urodeles have lost many cranial bones; they have reduced the ribs, they have lost entodermal gills and gained those of ectodermal origin; they have lost the Eustachian tube, but they have retained many features which make them extremely interesting in connection with all phylogenetic speculations.

If, now, we advocate the amphibian origin of the mammals, we must consider the arguments of those who would derive them from the theromorphous reptiles. The chief of these are as follows:

In certain theromorphs, as in most mammals, there is a heterodont dentition; incisors, canines, and molars being differentiated. This, however, is not conclusive, since a heterodont

[1] For our knowledge of the development of the lymphatic system of the urodeles we are largely indebted to the unpublished investigations of Dr. F. D. Lambert.

dentition is not extremely rare in the non-mammalian vertebrates, which are certainly far removed from the mammalian line. On the other hand, the theromorpha have single-rooted teeth throughout, while certain of the dinosaurs have them with two roots. Heterodont dentition may easily be explained by parallel development from similar conditions.

In the theromorphs, as in the higher mammals, the coracoid is united to the scapula. This point is as favorable to the amphibian as to the theromorphous ancestry, since a similar state of affairs occurs in certain existing urodeles.

In theromorphs, as in mammals, there are bicipital ribs, one head articulating with the neural arch (diapophysis), the other with centrum or intercentrum. Here again the urodeles will fill the bill.

In the theromorphs, as in many mammals, there is an entopicondylar foramen in the humerus. This seems a feature of minor importance, since it is lacking in many mammals, while it is developed in some forms (*e.g.*, Hatteria) which cannot have had a theromorphous ancestry.

In the theromorpha, ischium and pubis fuse to form an innominate bone. This feature also occurs in certain urodeles as well as in some other reptiles.

In certain theromorphs (Clepsydrops) there is a differentiation of calcaneum and astragalus, recalling the relations in the mammals. Unfortunately, almost nothing is known of the foot structure in other theromorphs, and the resemblances pointed out in Clepsydrops are not conclusive. In all other sauropsids there is a strong tendency towards the development of an intratarsal ankle joint. Certainly the mammalian tarsus could have been derived directly from that of the Amphibia instead of indirectly through the theromorphs.

There is one serious objection to the theromorphous ancestry of the mammals upon which sufficient weight has not been placed. This view assumes that the suspension of the lower jaw in the theromorphs is, at least in part, homologous with that in the mammals. It assumes that the glenoid fossa of the latter has arisen by the squamosal of the reptile usurping the functions of the quadrate. But here lies a difficulty other than

that presented on a preceding page. If this assumption be true, the articular head of the mammalian lower jaw should represent the articulare, while between this and the tip of the jaw, several bones — angulare, splenial, dentary — should occur. In fact, the lower jaw in every mammal, so far as known, ossifies as a single membrane bone, which we prefer to regard, until better evidence is forthcoming, as the dentary of the lower vertebrates. The articulare we recognize in the body of the malleus, while since a new fulcrum of the lower jaw has been formed, the other bones, angulare, supra-angulare, splenial, etc., having no longer cause for existence, have disappeared without leaving a trace behind. Their proper position would be around that portion of Meckel's cartilage which for a while persists between the malleus and the osseous lower jaw.

In examining the shape, relations, etc., of the manubrium, which, as was noticed above, arises separately from the rest of the malleus, one can hardly fail to be struck with its resemblance to a somewhat reduced visceral arch. This resemblance is the more interesting since the cartilage appears in the very place where, according to several students of the problem of the segmentation of the vertebrate head (Dohrn, van Wijhe, Beard, Locy, Neal, etc.), a segment has apparently almost entirely disappeared from the vertebrate head. Whether this and the distal cartilage of the reptilian columella be the visceral arch of the missing segment, and whether the Eustachian tube really represents two confluent gill slits, we do not at present care to discuss.

DESMOGNATHUS FUSCA (RAFINESQUE) AND SPELERPES BILINEATUS (GREEN).

HARRIS H. WILDER.

As the two species which form the subject of this paper are widely distributed over the United States, it is probable that the differences in environment in the different regions may cause them to vary somewhat in their mode of life. The observations recorded here are confined to the Counties of Berkshire, Franklin, Hampshire, and Worcester, in the state of Massachusetts, and the statements made concerning their frequency, manner and times of occurrence, etc., are primarily applicable to this region. It will also be noticed that the authors quoted, with the exceptions of BAIRD and COPE, have in mind a restricted locality in each case (Massachusetts, Maine, New York) not far from the region in which these observations were made.

The object of this paper is to render available for laboratory purposes, and especially for the study of histology, two of our abundant native salamanders, which have hitherto been too much neglected, both because they are not easily found without a little experience and because they are apt to be confused with each other, especially during their larval life. The ease with which European investigators may obtain and identify their one classical species, *Salamandra maculosa*, without needing to be experts in systematic literature, or running the risk of erroneous conclusions by confusing externally similar species, is often envied here in America, where our very wealth in Urodelan material is a frequent source of vexation to the investigator, who realizes that even in histological research he cannot afford to be mistaken in the species studied. The two species considered here present many advantages which should make them favorite animals for laboratory research, when the

difficulties of finding them and distinguishing them from each other are once removed.

Early Reports of their Occurrence. — The earlier writers on the subject seem to have considered both species very rare, a circumstance which must be attributed wholly to their habit of concealment and the difficulty of finding them to one not familiar with their ways. They are evidently indigenous species, and we cannot here have to do with a recent increase in numbers, as in the case of the English sparrow or the periwinkle (*Littorina*). The first of these two salamanders to be discovered was *Desmognathus fusca*, first described by RAFINESQUE ('**20**) as *Triturus fuscus*, described later by HARLAN ('**22**) under the name of *Salamandra picta*; and cited as such by STORER ('**37**) in his "Report."

STORER states that he has never met with this species himself, but includes it in the list of Massachusetts Amphibia on the authority of Dr. PICKERING, who had seen one specimen that was found in a well in Ipswich, Mass.

DEKAY ('**43**) includes this species among the fauna of the state of New York, on the ground that it has been found both in Massachusetts and in Pennsylvania. The other associated species, *Spelerpes bilineatus*, does not appear to have been reported by any of the above authors, and was first described by GREEN ('**18**), who found it in New Jersey and named it *Salamandra bilineata*. It is thus clear that the two species in question, in spite of their abundance, were considered rare by the earlier authors.

Of especial interest to me has been a more recent report, by J. A. ALLEN ('**68**), on the Amphibia "found in the vicinity of Springfield, Mass.," in which he adds, after the name *Spelerpes bilineatus*, "one specimen, rare."

The next name on the list is that of *Desmognathus fusca*, which he has not found at all, but quotes it as having been found in the state. He writes that this species is "equally rare with the preceding" (*i.e.*, *S. bilineatus*). This failure to find these two commonest species is the more singular since the author proves himself a careful collector by including in his list such species as *Pseudotriton salmoneus* and *Plethodon gluti-*

nosus, which are rarely met with in this locality. It cannot be said, however, that all authors are in accord concerning the rarity of these two salamanders. It is noticeable that BAIRD ('50) and COPE ('89), both of whom had exceptional opportunity to study specimens from an extensive area, do not consider it rare. COPE ('89) distinctly states, on the other hand, that *D. fusca* is "perhaps the most abundant salamander in N. America."

Habitat. — Both of the salamanders in question are similar in habit and are commonly found associated. Although both are very common, they are so skilfully concealed, at least by day, that special knowledge is necessary in order to collect them in abundance. This is doubtless the reason why they have been considered rare.

They are found in and about running brooks that are plentifully supplied with small stones, and they seem to prefer spots shaded by trees. Perhaps the best brooks of all are the little mountain streams that run swiftly down quite steep inclines, forming miniature cascades alternating with small shallow basins. Mountainous regions abound in such brooks, which may be usually located from a distance by noting the places where the slopes of two hills converge, forming a ravine. When such a brook is found, begin the search by turning over all the stones and bits of fallen logs that lie in the immediate vicinity of the edge of the brook. Stones, lying a foot or more above the water and upon the dry bank, will yield nothing, and, on the other hand, stones nearly or wholly submerged in the flowing water will be profitless, since any animals contained beneath them may easily escape by slipping along with the turbid current. The best stones are rather irregular ones, lying on the edge of the brook, and with the bottom surface just below the level of the water. The right sort of a stone, when lifted, should reveal a shallow cavity formed in the wet sand or mud, but containing little or no water at the moment at which the stone is removed.

A little experience will enable the seeker to determine just which stones or other objects lie in the right position to serve as protection for the salamanders, and thus the labor becomes

much lessened. Since the adult salamanders are extremely slippery and often very rapid in their movements, it is advantageous to keep in one hand a small net of cheese cloth, having an aperture about six inches across, and with a very short handle.

The larvæ of both species are to be sought for in the water, and may be seen lying upon the bottom of the quiet pools, especially those with a fine gravel bottom. Even at this stage they are fond of concealment, and if there are small stones, fallen leaves, or other objects in these miniature basins, they should be removed and the water allowed to settle. The larvæ may be easily captured by means of the net. This should be laid upon the bottom and the larva driven into it by approaching it from behind with the hand or a small stick. The great majority of the larvæ collected in this way are those of *Spelerpes*, as it remains much longer in the larval state, but the very similar larvæ of *Desmognathus* occur in similar places and are very difficult to distinguish from the others. (See below.)

Adults. — As the two species belong to different subfamilies, it would seem an easy matter to distinguish the adults, but unfortunately the most distinctive characters are skeletal, and the external feature, such as color, number of costal folds, etc., although noticeably different in extreme or typical specimens, show so many gradations and intermediate forms that the determination is in many cases extremely difficult. Both species are dark above, marbled along the sides, and without pigment ventrally. Both species possess a broad dorsal stripe with crenulate edges. This stripe in typical specimen of *D. fusca* is very dark brown, so that in living specimens it merges almost indistinguishably into the dark slate color which limits it laterally. In the other species the dorsal stripe is usually light brown or fawn color, lighter at its outer edges and bordered by a very dark brown stripe, hence "*bilineatus*." It is, however, quite usual to find specimens of *D. fusca* with a light rufous dorsal band, set off very conspicuously from the slate-color at its outer edges ; while in many specimens of *S. bilineatus* the dorsal band is quite dark, without lighter edges, thus blending

into the dark lateral line which in time becomes lost in the dark color of the flanks, the result being similar to that seen in the lighter specimens of *D. fusca*. The ventral side furnishes a surer test, as it is usually of a light lemon yellow color in *S. bilineatus* and white and semi-transparent in *D. fusca*.

This yellow color of the former species changes to a light salmon pink in specimens thrown alive into aqueous corrosive sublimate. As for general shape and size, *D. fusca* attains a greater size, and in these large specimens (10 cm. +) the large muscles of the jaw form definite protuberances upon the head. *S. bilineatus* is not as robust a species as the other, and the tail particularly seems more slender and longer in proportion. The number of costal folds may often be useful as a diagnostic, but this character seems liable to individual variation, and one is always in doubt where to place the beginning and end of the series counted. In *D. fusca* there are generally twelve folds (*i.e.*, the myotomes, not the myocommata) between the fôre and hind limb, while *S. bilineatus* shows usually fourteen or fifteen. These numbers can, however, be used for comparison only in a general way, for the relative position between these folds and the place of origin for the limbs appears to be subject to variation. Perhaps the surest method of distinguishing is to collect a few typical specimens of each, and use them as standards for comparison, employing the other diagnostic points as they may seem applicable in individual cases.

Eggs. — The eggs of *S. bilineatus* appear to be the more common, or at least the more usually found, and may be obtained during May and June. I have found them at the following dates: May 27, June 12. They are deposited in a single layer upon the lower side of submerged stones, each batch containing from 30–50 eggs. The stones which are suitable for this purpose must be in the form of an arch allowing the water to flow beneath, as in the diagram, Fig. 1. They are generally in the more rapidly flowing portions of the brook, but the depth of water must be such that the eggs are at all times entirely submerged, as the dash of the surface ripples striking against them would subject them to mechanical injury.

The eggs appear attached to the surface of the stone by gelatinous threads proceeding from the outer envelope, and although they are generally contiguous, they are each attached separately. Within the eggs the embryos lie free, the heavier

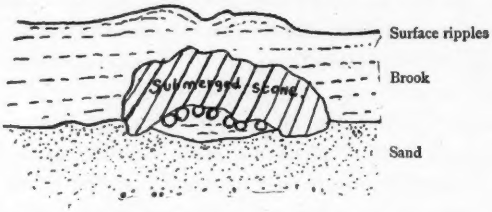


FIG. 1. — Diagram showing method of deposition of eggs employed by *Spelerpes bilineatus*.

yolk being always beneath. When the normal position is changed by the sudden overturning of the stone, the eggs roll over simultaneously in order to resume their normal position.

The eggs and their manner of deposition have been well described by VERRILL ('62, '63), although the author considers

FIG. 2. — *Desmognathus fusca* ♀ with egg-rosary. Natural size.

them as the eggs of *Desmognathus fusca* and describes them under that name.

The eggs which really belong to this latter species, as described by BAIRD ('50) and later by COPE ('89), are laid in a long string and wrapped around the body of the female like a rosary. COPE's statement is as follows: "Professor Baird originally noticed the curious disposition of the eggs in this species,

which I have verified on a few occasions. As in the Anurous genus *Alytes*, the eggs, on emission, are connected by an albuminous thread, which soon contracts and hardens. One of the sexes protects this rosary by wrapping it several times round the body and remaining concealed in a comparatively dry spot. How long this guard continues is not known." (COPE, '89, pp. 196, 197.)

After searching for such eggs during several seasons in vain, I was able finally to confirm these statements by means of a batch of eggs which were laid in my laboratory *terrarium*. When found (June 1, 1898), the position of the mother and

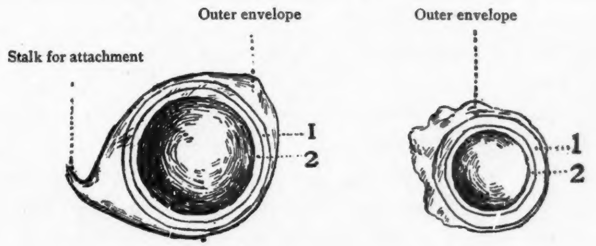


FIG. 3. FIG. 4.

FIG. 3. — Egg of *Desmognathus fusca*. × 5.
FIG. 4. — Egg of *Spelerpes bilineatus*. × 5.

eggs was as represented in Fig. 2, which is drawn as though looked directly down upon from above.

The adult lay beneath a brick and in an irregularly oval hollow made in the mud, evidently by herself.

The eggs, which showed then no signs of development, and which must have been just laid, were, indeed, wrapped about the body of the parent, but not in a definite single string. Each was surrounded by a loose outer membrane which tapered a tone end to a strong cord, and several or all of these cords seemed to focus at a single point, much like a bunch of toy balloons held in the hand of a street vender. The attachment to the body was loose, and was evidently effected by the female by winding her body in among the strings. The eggs changed their position somewhat from day to day, as though, by the movement of the parent, new combinations had been

produced. It is even possible, in consideration of the marked nocturnal habits of this species, that the female may leave the egg-mass during the night, returning to it by day.

Comparison of the Eggs. — The comparative size of the eggs of the two species is shown in Figs. 3 and 4, in which they are drawn five times the natural size. Each appears protected by three membranes, two that fit closely and an outer loose one. It is by means of strings proceeding from this latter that the one is attached to the parent and the other to the surface of the stone, although in the latter case there appears to be a definite adhesion, in which not only the stringy processes but also the surface of the membrane itself participates. As the development shows, the egg of *Spelerpes* is holoblastic, like the more usual amphibian egg, while that of *Desmognathus* is meroblastic.

Development of Spelerpes. — Figs. 5–19 represent a series of views illustrative of the external development of *Spelerpes* and drawn to the same scale (× 5). As the eggs used in these observations were of several different ages, it was not easy for me to fix definite time-limits to the several stages.

The oldest eggs collected were almost at *Stage d* when found. *Stages a–d* rest upon observations made upon the youngest lot collected ; *e–h* are consecutive stages of the oldest lot. As I have the dates of the stages figured, the record is complete, except for the time between *d–e,* which may be from 24–48 hours. The record, compiled from my notes, is as follows :—

Stages a and b. The youngest eggs collected May 27, at 10 A.M., showed no visible traces of external folds. Their appearance 24 hours afterward (10 A.M., May 28) is represented in Figs. 5–9. The development was somewhat uneven, and *Stages a* and *b* were selected as the extremes.

Stage c. These were drawn from the same lot as *a* and *b,* six hours afterward, May 28, 4.10 P.M. (Figs. 10, 11.)

Stage d. Killed May 29, 12.20 M. (Figs. 12, 13.)

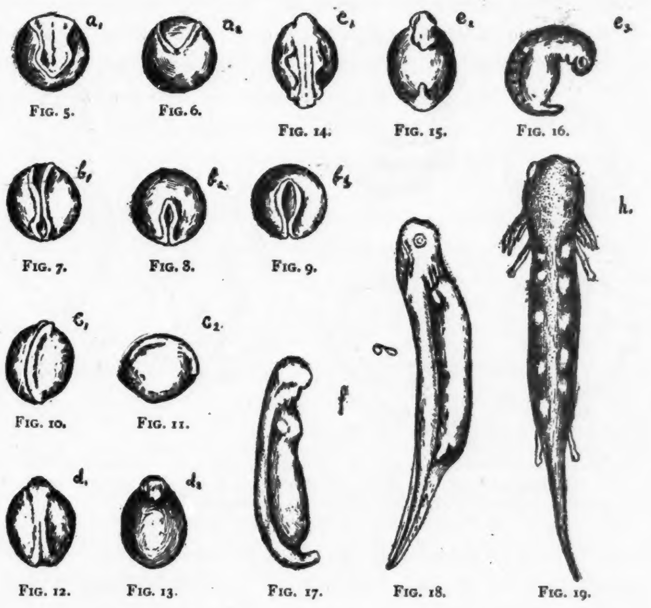
Stage e. These are from another and more advanced batch of eggs. All the other stages are taken from this lot.

The specimens of *Stage e,* as figured here (Figs. 14–16), were killed May 28, 4 P.M. The time it takes *Stage d* to reach the

development shown by *e*, I cannot tell, but suppose it to be 24–48 hours.

Stage f, June 1. (Fig. 17.) Embryos move in eggs when disturbed.

Stage g, June 6. (Fig. 18.) For this stage I have the following memorandum: "When taken out of egg membranes, swim about in watch crystal very vigorously for a few seconds and



FIGS. 5–19. — Developmental Stages of *Spelerpes bilineatus*.

repeat this each time when touched. Dorsal surfaces show pigment, light grayish appearance. Under lens, minutely mottled with pale gray dots (pigment cells), 6–7 little squarish areas left unpigmented in double row along back. These are to be the characteristic light spots of the larvæ." 5–7 days after reaching this stage the larvæ hatched. In the first case observed, June 11, the eggs broke when extracted from the water and liberated the larvæ. A note as follows: "It had to be *caught* with the little net; it swam about rapidly from one

side of the tank to the other and *avoided* the net. Could not be caught with a watch crystal. Movement, avoiding the net, etc., as in older larvæ." On June 13 the rest hatched.

Stage h. (Fig. 19.) Killed June 16, three days after hatching, 12.5 mm. long.

Development of Desmognathus. — Although I have fewer stages here to record, I can be more certain with the time-ratios between the stages, since all the observations were made upon a single batch of eggs, the ones described above, found

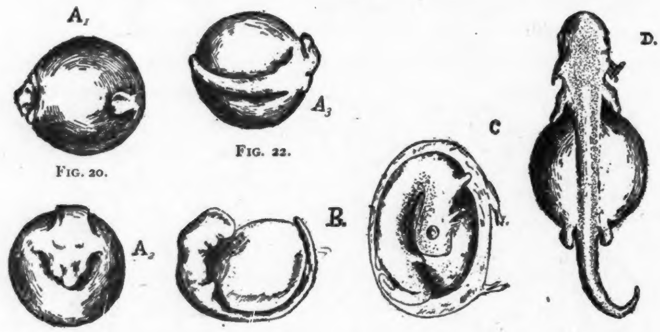


Fig. 20. Fig. 22. Fig. 21. Fig. 23. Fig. 24. Fig. 25.

Figs. 20–25. — Developmental stages of *Desmognathus fusca*. In the above series the stages are represented by letters, small letters for *Spelerpes* and capitals for *Desmognathus*. The stages in the two series do not correspond. Different views of the same stage are designated by numbers attached to the letter. *All the figures are magnified five times.*

June 1, and probably laid the night or the day previous. My observations cover but four stages, as figured here, and the dates of the stages are as follows:

Stage A (Figs. 20–22), June 11.
Stage B (Fig. 23), June 14.
Stage C (Fig. 24), June 18.
Stage D (Fig. 25), June 21.

The pigmentation which was distinctly noticeable in *Stage C* had by June 24 distributed itself in the characteristic pattern, leaving little unpigmented squares in the manner described for *Spelerpes*. I killed the last embryo June 30, at which date the

specimen, although still in the egg, and leaving a large yolk-sac, was in other respects a fully developed larva. The pigmentation was complete, the external gills fully developed, and the feet had the full number of distinct toes (4 anteriorly, 5 posteriorly).

Larvæ of Desmognathus fusca. — From the suggestions of the previous paragraph, it becomes probable that the larva of *Desmognathus* remains in the egg until very well developed. My oldest embryo, taken from the egg June 30, is 13 mm. in length, still possessing so large a yolk-mass that it was evidently intended to remain in the egg for a much longer time.

I have taken *Desmognathus* larvæ only during the months of August–October, and these vary from 20–30 mm. in length, with external gills much reduced.

During fall and early winter the smallest adults are found 35–40 mm. in length, and differing from the largest larvæ mainly in the absence of the external gills.

Summing up the evidence, it becomes probable that the larvæ of *Desmognathus* remain in the egg until nearly adult, that they emerge from the egg in midsummer, that the gills, smaller at the time of hatching than at an earlier embryonic period, become gradually lost — a process which becomes complete during the late fall of the same year in which the eggs are laid. This history will readily explain the fact why the larval *Desmognathus*, perhaps the commoner of the two species considered, is so rarely met with. I have collected many hundreds of the larvæ of *S. bilineatus*, and a very few, not more than twenty in all, of the larvæ of *D. fusca*. In habits these larvæ resemble the adults. They avoid the deeper pools which abound in the larvæ of the other species, and lie where it is very shallow or in the wet sand, where they may find in places just water enough to cover them. When alarmed they run rather than swim, often abandoning the water, running with a series of quick jumps over the wet sand. COPE's only mention of this larva is so short and couched in such general words as to be applicable to either species. He says: "Its delicate larva may be observed darting rapidly from place to place, seeking concealment among mud and leaves." The color and marking

of this larva, as before mentioned, are identical with those of the larva of *S. bilineatus*, and are thus useless as a distinguishing test.

Larvæ of Spelerpes bilineatus. — The larvæ of *S. bilineatus* hatch early and continue for a long time in the larval state, probably 2–3 years.

COPE ('89) says: "It is one of those species whose metamorphoses are prolonged and which remains in the larval state until nearly grown." VERRILL ('62, '63) says of it, under the name of *D. fusca:* "The young become quite large before losing their gills." This description cannot apply to the genuine *D. fusca*, as has just been shown, and as the author has described in the same paper the eggs of *S. bilineatus*, the larvæ he found undoubtedly belonged to this latter species, concerning which the statement is an accurate one. The growth must be exceedingly slow and dependent upon the fortune of the individual in securing prey. I have caught all stages from 16–52 mm. at all seasons of the year, and see no indication that those larvæ collected at any one time represent one, two, or three years of definite growth.

For the purpose of studying this point I went to Williamstown, Mass., in September, 1896, collected 90 larvæ, and measured and tabulated each.[1] The result of this is shown graphically in Fig. 26, in which the ordinates represent the total lengths in millimeters, and the abscissas the number found. The results seem to show, in general, merely a decrease in numbers as the animal gets larger, which was to be expected.

There are gaps in one or two places, indicating sizes that I did not find, but these are by no means wide enough to represent a year's growth. 52 mm. represents about the limit of size reached by the larvæ under the most favorable circumstances. I have found adults a little smaller than this.

Differentiation of the Larvæ. — The fact that the larvæ of *S. bilineatus* are exceedingly common, while those of *D. fusca* are rare, renders it *a priori* probable that a given larva belongs

[1] I was materially assisted in the collection of these larvæ by my good friend, the late Dr. James I. Peck, whose kindness I most pleasantly remember in this connection.

to the former species. This may become a certainty if the larva be above 35 mm. in total length. At about 20 mm. the larvæ of *D. fusca* have very small external gills, and the tail fin is obsolescent; while larvæ of *S. bilineatus* of the same size have very apparent external gills and a very broad tail fin, ending obtusely. In general, the larva of *D. fusca* is at all stages suggestive of maturity, while that of *S. bilineatus* is larval and piscine in its general appearance. The former resembles *Amblystoma* in shape, the latter *Necturus*. The former has a

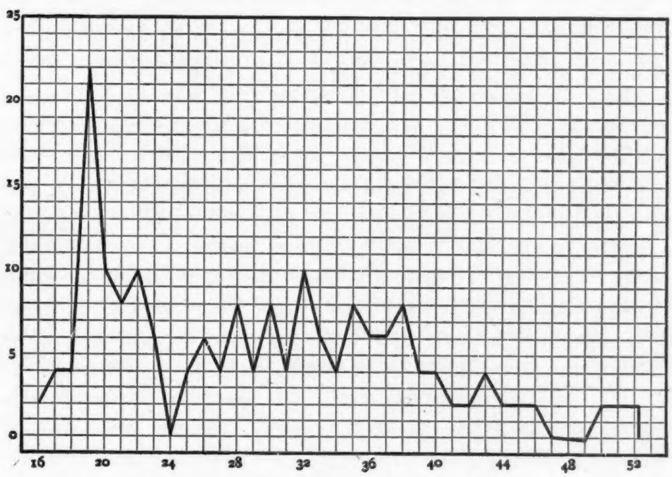


FIG. 26. — Curve showing frequency of the larva of *S. bilineatus* at its different stages.

short head, rounded above, shows well-marked costal folds, has robust limbs and a narrow tail fin. The latter has a long flat head, obscure costal folds, and a very broad tail fin. A definite distinguishing characteristic does not seem to exist, but there are so many general distinctions that a person who has once studied and compared the two will find no difficulty in identifying each species at any stage.

Method of Rearing in Confinement. — The adults of both species, because of their peculiarities in respiration and the consequent necessity of keeping their skin moist, cannot be kept either in water or in a dry atmosphere, but may easily

be kept for months or years in an ordinary fernery where the atmosphere is constantly saturated with moisture. I have in my laboratory a large fernery or *terrarium*, about 2 × 3 feet square and 2 feet high. The bottom consists of a zinc tray, 8 inches deep and water-tight. The top and sides are of glass and the front side runs in a frame with weights, being thus capable of being raised and lowered like an ordinary window-sash. In the bottom of this there are about 6 inches of good garden soil, in which are planted ferns and other wood plants. The surface is partly covered with moss, and here and there are placed several stones, the size of one's fist, and a few pieces of rotten stump, arranged so as to give shelter to the adults. In one corner a crystallizing dish is sunk to the level of the soil. This is filled with water and the bottom covered with a little fine sand. Some duckweed, or Salvinia, may be placed upon the surface, and a few small stones should be put in a dish. At the beginning of the season, after arranging everything as above, enough water is poured in to drench the soil, and the sunken dish is filled. After this the *terrarium* is self-regulating. The water that evaporates is re-precipitated as moisture, and the total loss from the little pond in the corner is so slight that it needs replenishing not oftener than once in six months. If the *terrarium* is to support many animals, it is better to place a few earthworms, myriapods, etc., in it; and if the pond is designed for the rearing of larvæ, supplies of Entomostraca and a little Spirogyra to feed them with should be occasionally introduced. I have tried placing tiny bits of meat in prominent places, but they merely mould and have to be removed. I have kept as many as 20–30 adults and a dozen larvæ in my *terrarium* during an entire college year, and several times, on clearing it out in the fall after the summer vacation, I have found alive and in good condition adults which I had been unable to find in the spring, when I intend always to remove the animals. It seems most probable that these salamanders find enough to eat among the worms and insects introduced with the earth and plants, as they always appear in perfectly normal condition and contrast very forcibly with *Diemyotylus*, which grows thin and often starves to death when placed under

the same conditions. An examination of stomachs would, of course, settle this point; but I do not happen to have on hand at present any specimens which are known to have been kept for a long time in this manner.

Advantages as Laboratory Animals. — The advantage suggested in the previous paragraph is an important one, being animals that may be *easily kept in the laboratory during the winter without feeding or other attention.* To collect them from the *terrarium*, lift up the stones exactly as when in the field, or else wait until 9 or 10 P.M., and bring a light suddenly upon them. They are nocturnal and at such times forsake their concealment and crawl about over the glass sides and roof.

A second great advantage is that they *may be collected out of doors all the year round, except during the time of deep snow.* I have collected them with ease here in December and in March, thus leaving an interval of not more than 8–10 weeks during which they cannot readily be obtained. The eggs are peculiarly adapted to all sorts of experimentation; they lack the black pigment of the frog's egg, and thus give better results in staining. As their development is later in the year, they may be obtained after the eggs of frogs and toads have disappeared. The eggs of *S. bilineatus* develop readily when removed from the rock on which they are laid, if they are placed upon sand in a dish of water into which fresh water is constantly being introduced through a small pipe or glass tube. Those of *D. fusca* develop in the *terrarium*, and may be removed singly from the mass without disturbing the parent. It is highly probable that a mass of *Desmognathus* eggs would develop equally well when removed from the parent, if kept in the *terrarium* under the usual conditions; but I have not yet had an opportunity to test this, and it is at least possible that necessary moisture and even warmth may be derived from the body of parent.

BIBLIOGRAPHY.

ALLEN, J. A., '68. Catalog of the Reptiles and Batrachians found in the Vicinity of Springfield, Mass., with Notices of all the Other Species known to inhabit the State. *Proc. Boston Soc. Nat. Hist.* XII. pp. 171–204.

BAIRD, S. F., '50. Revision of the North American tailed Batrachia, with Descriptions of New Genera and Species. *Journ. Acad. Phila.* Second series. I. p. 281.

COPE, E. D., '89. The Batrachia of North America. *Bull. U. S. National Museum.* No. 34. Washington.

DE KAY, J. E., '43. Zoology of New York, or the New York Fauna.

GREEN, '18. *Journ. Acad. Phila.* I.

HARLAN, '22. *Journ. Acad. Phila.* V.

RAFINESQUE, '20. *Annals of Nature.*

STORER, D. H., '37. Report on the Reptiles of Massachusetts.

VERRILL, A. E., '62. Notice on the Eggs and Young of a Salamander (*D. fusca* Baird) from Maine. *Annals Nat. Hist. Boston.* IX. p. 253.

THE POISONS GIVEN OFF BY PARASITIC WORMS IN MAN AND ANIMALS.

G. H. F. NUTTALL.

MANY of the symptoms affecting the human subject as well as animals who harbor parasitic worms have been attributed by certain authors to poisons which the latter develop within the body of their host. Peiper, of Greifswald, recently published an article in which he gathered together a good deal of evidence from scattered sources, evidence which very clearly proves that a number of worms do give off poisons.

In the case of the Ascari (familiarly called round or maw worms), which are found in man, the pig, the cat, and horse, the evidence is very striking. There are a number of cases recorded where children who suffered from convulsions, loss of consciousness, great loss of flesh, anæmia, and other symptoms, were promptly and permanently cured of all of these by the use of medicines ("anthelmintics," vulgarly called "worm medicines"), which removed the parasites from the body. A number of authors have claimed that these parasites were simply injurious through their presence as foreign bodies within the intestine, as well as through their boring, their active movements, and their robbing their host of his proper share of the food he had eaten. That these worms contain some poisonous substance was claimed by Miram, who whilst studying the *Ascaris megalocephala* suffered twice from attacks of sneezing, swelling of the eyelids, and excessive secretion of tears, besides severe itching and swelling of the fingers which had been in contact with the worms. Von Linstow noted that when these worms were cut open they gave off a sharp, peppery odor and caused tears to flow from his eyes. Inadvertently touching his eye with a finger which had been in contact with these worms, a very severe inflammation of the conjunctiva, with a condition known as chemosis, resulted. Raillet, Arthus,

and Chanson had similar experiences. The latter two observers, working with an ascaris from the horse, suffered in addition from pain in the throat and loss of voice. These experimenters found that two cubic centimeters of the fluid taken from the inside of these worms would kill a rabbit.

Kolbe, of Reinez, after having read Peiper's publication, above referred to, reported a remarkable case of a child he had unsuccessfully treated with the regular worm medicines. The boy had suffered for over a year from severe abdominal pains, frequent attacks of fainting, and convulsions. The doctor having been unsuccessful, a friend of the boy's mother — a baker by trade — suggested that she should rub up a dried roundworm with sugar, and make the boy take it. This "homœopathic" remedy had an immediate effect; two tangled masses of worms the size of a fist being given off by the patient, who made a prompt and complete recovery. Cobbold and Davaine have reported cases where various nervous symptoms had subsided on the removal of tapeworms. Marx saw an epilepsy of three years' standing cease on the removal of a *Tænia solium*. It is curious that the eyes are so frequently affected in those suffering from tapeworms. It is quite possible that this is due to the effects of a poison circulating in the blood, the same having been absorbed from the intestine where the parasite is domiciled. In five out of fourteen cases of patients harboring the tapeworm known as *Tænia nana*, Grassi observed serious symptoms resembling those of epilepsy.

Another worm, the Bothriocephalus, may cause severe anæmia, which has variously been explained as due to a peculiar poison, to effects resulting from the *death* of the worm, or to the length of time that the individual has harbored the parasite. A blood-sucking worm, the Anchylostoma, which may occur in hundreds and even thousands in the intestine, was believed by Lussana to contain a poison, and not to injure its host simply through the loss of blood it entailed. Looss, of Cairo, also states his belief, in a recent publication, that these parasites contain a poison. Working with the larvæ of this worm last summer, he found that even after carefully washing them, they caused dogs which had swallowed them to vomit, whereas the

water in which the parasites had been washed had no effect on the dogs.

The *Tænia ecchinococcus*, a tapeworm which in one form of its parasitic life gives rise to the condition called "Hydatid cyst," also gives off a poison, for the fluid taken from the cyst has been shown to be toxic by Debove and Humphrey, who experimented on men and animals. This explains the severe symptoms and even death which may follow the puncture of a cyst by the surgeon, or its spontaneous rupture. There is also reason to believe that the Trichina and other parasitic worms give off poisons. At any rate, we have a fruitful field of investigation open to research along these lines, and there may be a good deal in the home remedy of the baker worm-specialist!

Hygienic Institute University of Berlin.

A CURIOUS MALFORMATION OF THE SHIELDS ON A SNAKE'S HEAD.

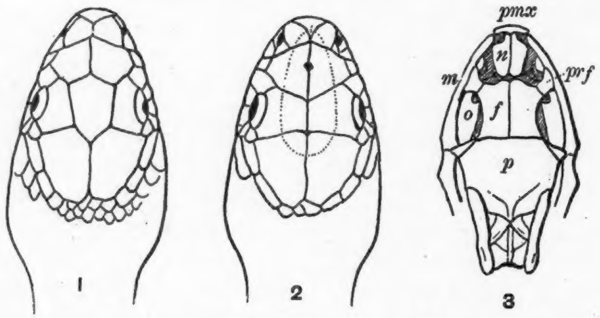
LEONHARD STEJNEGER.

DR. JOSUA LINDAHL, director of the Museum of the Cincinnati Society of Natural History, recently sent me a snake for examination which had defied all attempts at identification on account of the extraordinary scutellation of the top of the head. It was an old specimen found in the basement without label and without indication of origin or locality. Its color is entirely faded out, the snake is extremely emaciated, and the preservation of the body is bad. However, I think I make out 25 scale-rows, 229 ventrals, a double anal, and about 80 caudals; Lindahl's measurements are: length, 53 inches; tail, 8¾ inches.

The principal feature of the top of the head is the total absence of an unpaired frontal, the meeting of the supraoculars in a broad suture on the median line, and the extraordinary size and shape of the prefrontals. In the suture between the latter there is a deep pit filled up with soft skin, and the rostral shows some signs of damage by violence. These features and the general extraordinary aspect of the top of the head are shown in the accompanying sketch (Fig. 2). In all other respects the snake appeared to be normal, and while the above-mentioned features looked outlandish enough I was soon convinced that I had only to do with a most abnormal specimen of the typical colubrine snakes. An examination of the dentition and other structural characters showed that the specimen belonged to the genus commonly known as *Coluber*, while the more minute details of the scale formula, *viz.*, one preocular, two postocular, two large anterior temporals, in addition to those given above, pointed directly to *Coluber obsoletus*, the common "mountain black snake" of the eastern and Austroriparian faunas of North America. A direct comparison with specimens of this species confirmed the correctness of the identification. For the sake

of illustration I add a sketch of the upper surface of the head of a normal specimen (Fig. 1).

In considering the cause of this malformation I was attracted by the pit in the inter-prefrontal suture, and it at once struck me that it was located in the fontanelle, between the nasals and the frontal bones. The meeting point of the inter-supraocular suture with that of the inter-parietal suture also shows soft skin. The median suture between this point and the pit corresponds to the suture between the frontal bones. A sketch of the top of the skull of the species is added (Fig. 3) to make



Diagrams of top of head of *Coluber obsoletus*. Fig. 1. — Normal specimen. Fig. 2. — Malformed specimen. Fig. 3. — Top of skull: *f*, frontal bone; *m*, maxillary; *n*, nasal; *o*, orbit; *p*, parietal; *pmx*, premaxillary; *pxf*, prefrontal.

these points clear. Knowing the regenerative power of the reptilian tissues, I could not escape the impression that the true explanation of the malformation is an injury to the skin of the top of the head, by which the whole derm from the rostral to beyond the posterior end of the frontal became removed. In healing, the covering of the wound probably started from the edges of the lacerated adjoining scutes, which continued to grow until they met on the mesial line. In the sketch (Fig. 2) I have indicated by a dotted line the probable extent of the injury, but I am bound to add that there is no indication in the specimen. It must be remembered that the epidermal covering is regularly shed, and that the outline of the wound which probably was visible in the first covering may have disappeared in the succeeding molts.

EDITORIAL.

The Society of Morphologists, at its recent meeting in New York, voted that the *American Naturalist* should be the official organ of the society. The Society of Morphologists is one of the most energetic of the societies affiliated with the Society of Naturalists, and includes a large proportion of the active workers in zoology east of the Rocky Mountains.

We are therefore very glad to accept the vote of the Society of Morphologists, and to place our pages at the disposal of the officers of the society for notices and of other members for communications on matters relating to the society. We shall be glad especially to receive papers read at the meeting of the morphologists, and so far as they are suited to the aims of the *Naturalist* to publish them.

The American Journal of Physiology. — In the beginning it was supposed that this new journal would occupy the field of general physiology as well as that of the more special applications of this science. As a matter of fact, the first volume is almost exclusively physiology of the medical schools, and the second volume promises much the same. Criticism is not directed toward the editorial board of the new journal, but toward the younger physiologists, who are working on general problems, but who have not supported the journal by their contributions.

Laws of Priority. — One of the most notable works which has appeared on our table for several years is the *Fishes of North and Middle America*, by D. S. Jordan and B. W. Evermann. These 3136 pages represent an immense amount of work, but, to our mind, they are marred by too strict an adherence to the laws of priority. In the interpretation of the statutes of our legislatures the judges of our courts are allowed the exercise of common sense; should not the same latitude be permitted in the applications of the laws of nomenclature? These laws are of human manufacture; they are framed, not by the whole body of scientific workers, nor by their representatives, but by the few; and their application without modification leads to endless confusion. A case in point is illustrated by these volumes. For years the pickerel, pike, etc., have been assigned to a

genus universally called Esox, but in these volumes the name Esox is transferred to the genus known since 1817 as Belone, while to the genus containing the pikes the name Luccius is applied. These changes are based upon the writings of Rafinesque, and if persevered in will lead to endless confusion. A few such changes and the scientific literature of America will be unintelligible to the students of Europe.

That the scientific world is not a unit in regarding the law of priority as inviolable is shown by their treatment of a somewhat similar case, where the attempt was made to change the names of many of the Lepidoptera upon the authority of Hubner's *Tentamen.* A strict adherence to the rule must result in the adoption of the Hubnerian names, but our entomologists will have none of them. If our systematists must have immutable laws, would not a law of limitation be a good one? Would it not be well to say that if a certain name has been in common use for, say fifty years, it shall not be replaced by some long-forgotten name, resurrected by some delver in antiquarian lore. That our radicals will not be followed by the more conservative Europeans is shown by numberless facts. No European naturalist will discard Amphioxus; Triton will hold its own in place of Triturus or Molge; and Dr. Boulenger hopes that a similar conservative spirit will work in the interests of stability in the nomenclature of the tailless batrachians of Europe.

REVIEWS OF RECENT LITERATURE.

ANTHROPOLOGY.

Origin of Culture.[1] — Notwithstanding the classical works of Bastian, Ratzel, and Tylor upon culture history, and the papers of others scarcely less eminent, L. Frobenius, in his treatise upon African Culture, deplores the fact that so little has been done to discover the origin of culture and that so little is known of the true "world-history." He compares the present state of culture with the joint or internode at the top of a bamboo stem. That which is beneath our internode is unknown to us; in whatever direction we may turn we are confronted by unsolved ethnological problems, so that our examination of the records of the past speedily terminates in the Aryan, Babylonian, and other questions. The author makes the usual observation in regard to the need of haste in gathering information and specimens from those inferior races who are being civilized off the face of the earth. A noteworthy feature of this memoir is the stress laid upon the "natural history method" of treatment. Frobenius declares that much has been heard of this method but little seen. Culture is continually compared to a living organism that has its birth, development, and decay; it is borne about by man, but changes much more slowly than he; it is through its study that we shall learn of the migrations of men and come to know something of the greater world-history. About 200 pages are devoted to the study of the "morphology" and the "comparative anatomy" of African culture, in which the internal structure, outward form, and the distribution of the huts, weapons, implements, and other artifacts are described in detail. Perhaps the most originality appears in the third part of the work, which is devoted to the "culture-physiology" of Africa. By this is meant the status of each art in its own particular life cycle; the declining and stationary arts include those of Negritic and Malay-Negritic origin, now represented by artifacts in wood and bamboo; the developing technic arts are of Asiatic and African origin, and are confined chiefly to articles of iron, hide,

[1] Frobenius, L. *Der Ursprung der afrikanischen Kulturen.* Berlin, Gebrüder Borntraeger, 1898.

and leather. Much that has been classed as "techno-geography" and "anthropo-geography" is included in this memoir under "culture-physiology." Frobenius has made a decided gain in lucidity and directness of presentation of his subject by employing this formal nomenclature; in less skillful hands it might lead to the warping of facts to fit them to the plan of research.

A series of 26 charts accompanies the volume upon which the various culture areas are indicated. There is a fascinating appearance of finality about such diagrams, yet, owing to the many sources of error in museum records, from which the charts were made out, they must at best be regarded as provisional and incomplete. The value of the memoir is enhanced by numerous illustrations in the text.

FRANK RUSSELL.

GENERAL BIOLOGY.

Embryos without Maternal Nuclei.[1] — By separating by hand under the microscope the unfertilized egg of the sea-urchin, Delage has obtained one part containing a nucleus and ovicenter and a part devoid of them. When these parts were placed in a drop of water containing a normal egg and spermatozoa were added, spermatozoa entered into all three pieces and all cleaved. The whole egg developed the most rapidly, the nucleated fragment came next, and the enucleate fragment most slowly. All were carried to the gastrula stage; the embryo without maternal nuclei being of small size and having the enteric and blastocœlic cavities nearly obliterated. Thus there has been effected the fecundation and development of a fragment of an egg without egg nucleus and without ovicenter. Delage draws the following weighty conclusions: —

1. It is necessary to reject as too strict the ordinary definition of fecundation — the union of the male and female pronuclei. This union occurs, but is not the essential phenomenon.

2. The definition of Fol — the union of two pronuclei and of two demi-ovicenters with two demi-spermcenters — must also be rejected. It must be rejected also on account of the often observed fact that the absence of the ovicenter offers no obstacle to segmentation.

3. Any theory must be rejected which explains fecundation by the saturation of a female nuclear polarity by a male nuclear polarity,

[1] Delage, Yves. Embryons sans noyau maternel, *Compt. Rend.*, 1898.

and also the theory that accounts for maturation on the ground that it is getting rid of the male element of an originally hermaphrodite egg nucleus.

4. All theories must be rejected which consider fecundation as the furnishing by the male of the number of chromosomes subtracted by the polar globules. The loss of one-half of the chromatic matter does not, of itself, prevent the egg from developing, for the half number of paternal chromosomes can make the egg develop.

5. The sexual attraction is not located in the nucleus.

6. Two things must be distinguished in fecundation: (*a*) the communication to the egg of a vital energy which permits it to segment and to develop; (*b*) the communication to the product of the advantages resulting from amphimixia and the possession of the paternal hereditary characters. As for the second point, my experiment furnishes no indication; as for the first, it shows that the theories of fecundation reconcilable with it are those which present the phenomenon as the conveyance by the male of a special energetic plasm (*Kinoplasma*) contained perhaps in the spermocenter.

7. There is in the ovular cytoplasm no fixed specific architecture whose conservation is a condition of development; if a structure exists, it is conditioned by the mutual reactions of parts and can reëstablish itself as often as it is altered.

8. The celebrated experiment of Boveri, so strongly contested, especially by Seeliger, is demonstrated, if not true, at least possible; the gravest objection that has been made to it (the impossibility of the development of an ovular cytoplasm without nucleus) being experimentally suppressed.

Temperature and Rate of Regeneration.[1] — It has long been known that in every organism there is an optimum temperature for growth above and below which growth occurs more slowly. That the same is true of regeneration has been shown by the recent work of Lillie and Knowlton on *Planaria torva.* Miss Peebles has done similar work on *Hydra grisea* and *H. viridis.* At 18–24° C., of *H. grisea* there regenerated in 2 days 0%; 3 days, 26%; 4 days, 95%; of *H. viridis*, 2 days, 38%; 3 days, 100%. At 26–32° of *H. grisea* there regenerated in 2 days, 75%; 3 days, 100%; of *H. viridis* in 2 days, 98.5%; 3 days, 100%. At 12° C. there regenerated of *Hydra viridis* in 4 days, 13%; 5 days, 24%; 6 days, 71%; 7 days, 100%.

[1] Peebles, Florence. The Effect of Temperature on the Regeneration of Hydra, *Zool. Bull.*, vol. ii, pp. 125–128.

At 38° C. polyps did not regenerate, but died. Hence the optimum lies between 30° and 38° C. *H. grisea*, at the room temperature (18–24° C.), regenerates more slowly than *H. viridis;* but it is relatively more accelerated by the increased temperature.

Experiments upon the relative effect of light of different wavelengths resulted negatively; but these experiments do not seem to have been carried out very thoroughly.

Organisms and Oxygen.[1] — That oxygen is necessary to the life of organisms is a dogma which seemed to have received a severe shock when the facts of anærobic bacteria (which are killed by the presence of free oxygen) became known.

Errara points out that after all this necessity for oxygen is one of degree. As there are certain species which need a large amount of oxygen, so there are others which have a very low optimum of oxygen supply; such are the anærobic forms. In the presence of a larger amount of oxygen they thrive less well, and may even die.

The Phylogenetic Significance of Protozoan Nuclei.[2] — The minute structure of the nuclei of Tetramitus, Microglena, Synura, Chilomonas, Trachelomonas, Stylonychia, Amœba, Euglena, Ceratium, Peridinium, and Noctiluca has been carefully investigated by Mr. G. N. Calkins. A considerable variety of nuclear types is recognized, the simplest of which is the distributed nucleus, which consists of isolated chromatin granules scattered about in the cell. Nuclear membrane and linin threads are absent; there is, however, a cytoplasmic body near which the chromatin granules gather at the time of division; the activity of this body is analogous to that of the centrosphere of more highly organized cells. Nuclear conditions of this type are found in Tetramitus. A higher form of structure is found in the "intermediate" type of nucleus which occurs in Microglena, Synura, Chilomonas, the euglenoids, in which the attraction-sphere is intranuclear, definite in form, deeply staining and active, and the chromatin granules are massed about it permanently, as in the forms just mentioned, or only during division, as in Paramœba. A nuclear membrane is found in the case of some nuclei of this "intermediate type." In higher types of nuclei the attraction-sphere is no longer intranuclear, but this position of vantage is taken by

[1] Errara, L. Tous les êtres vivants ont-ils besoin d'oxygène libre? *Rev. Scientifique*, (4) X, 688, 689, 26 Nov., 1898.

[2] Calkins, Gary N. The Phylogenetic Significance of Certain Protozoan Nuclei, *Annals N.Y. Acad. Sci.*, vol. xi (1898), pp. 379–400, Pl. XXXV.

the central spindle during division as in Noctiluca and many Metazoa. A distinct centrosome was found only in Noctiluca. The nuclei of most Protozoa belong, however, to aberrant types, which seem to have developed along divergent paths and only remotely resemble the more primitive forms on the one hand and the higher forms on the other. Examples of these aberrant types are found in *Amœba proteus*, Ceratium, Noctiluca, and the Infusoria in general. Chromosome formation is first seen in flagellates in the form of rods which arise by the union of the scattered chromatin granules. They form in the typical, though primitive, metazoan manner in Noctiluca and Euglypha, and all metazoan cells pass through these stages in preparing for mitosis.

C. A. K.

The Plotting of Biological Data in which it is necessary to exhibit an enormous range of numbers, as, for example, in certain lines of plankton work, presents a practical difficulty which may be obviated by a simple method suggested by Mr. D. J. Scourfield.[1] This is the use of logarithmically ruled paper, or of ordinary cross-section paper by the assignment of suitable values to the lines. Thus millimeter paper may be used if the centimeter lines are held to represent 1, 10, 100, 1000, etc., and the intermediate millimeter lines are given the numerical values whose logarithms are 0.1, 0.2, 0.3, 0.4, etc. For ordinary biological data, logarithmic ruling in one direction only is required, though for certain problems, *e.g.*, the plotting of variations of a rapidly increasing number of organisms, paper ruled in this manner in both directions might be used. This method of graphic presentation of biological statistics has the additional advantage of exhibiting *proportionate* changes in numbers by lines having the same angle of slope wherever situated in the chart.

C. A. K.

ZOÖLOGY.

Relationships of North American Grouse and Quail. — Dr. H. L. Clark has just published one of his useful papers on the feather-tracts of birds; in this case on those of the North American grouse and quail. The work of Nitzsch is thus carried on and[2] extended,

[1] Scourfield, D. J. The Logarithmic Plotting of Certain Biological Data, *Journ. Quek. Micr. Club*, Ser. II, vol. iv (1897), pp. 419–423, Pl. XX.

[2] Clark, Hubert Lyman, Ph.D., Instructor in Zoology, Amherst College. The

Dr. Clark having the advantage of almost exclusively basing his observations on fresh birds instead of dried skins, thereby escaping many errors unavoidable to his predecessor and being enabled to go into such details as are demanded by the more refined requirements of modern science. Thus, while Nitzsch only examined the skins of 5 species within the frame of Dr. Clark's article, the latter could work with 65 specimens in the flesh, representing 18 species and all the genera of the territory in question. His careful descriptions and figures are, therefore, very valuable to the systematic ornithologist, and the conclusions he bases upon them entitled to great consideration. But while thus restricted to fresh material, he is also limited to a small number of forms of the groups he treats of, and while this limitation in no way lessens the usefulness of the material, which he thus places in the hand of the working systematist, it naturally interferes with the trustworthiness of the generalizations.

In discussing his "conclusions" (pp. 651–653) it should be borne in mind, however, that Dr. Clark has been very careful and guarded in expressing his views, and that he has avoided to be dogmatic; nor does he claim that much light has been shed upon the origin or relationships of the larger groups. The relationships of the various genera within these groups, however, he thinks "is at least suggested by these investigations" to the extent that he ventures to express them in diagrams which look suspiciously like "stammbaums." But I am not certain that they mean more than a diagrammatic representation of the pterylographic "relationships" without reference to the true phylogeny of the species, unless he really believes that the pterylographic characters alone are sufficient to indicate the various shades of interrelation or the course followed in the evolution of these genera. This uncertainty is indicated by his speaking of the diagrams as "pointing out the relationship of the genera," though in the next moment he selects a type at the bottom of the series simply for the practical convenience of having "a starting point from which to develop the other genera." Seeing, however, that the diagrams have no real value unless meant for "ephylogenetic trees," whether standing on their roots or their tops, I shall discuss them from the latter point of view.

It is then plain that Dr. Clark, in spite of his guarded reservation, really regards the trees as standing on their roots, for he is careful to select the genera he starts from, on account of characters which

Feather-Tracts of North American Grouse and Quail, *Proc. U. S. Nat. Mus.*, vol. xxi (1898), No. 1166, pp. 641–653, Pls. XLVII–XLIX.

he claims to be more generalized than those of the other genera. As one of these generalized characters he regards the small number of rectrices, assuming that the forms with more numerous tail-feathers have increased them in the course of development. Thus he remarks that "*Dendragapus* has developed from *Canace* by . . . a marked increase in the number of rectrices." I think there can be no doubt that this is a fundamental error. The whole development of the tail of the birds shows that the generalized condition is that of numerous rectrices, and that the specialization, so far as number goes, consists in their reduction. I doubt very much that a pair of rectrices once *lost* can ever be redeveloped. If a reduction has already taken place and for some cause or another the tail is to answer a purpose temporarily suspended during the course of the evolution of a form, other feathers which have not undergone the retrograde movement are taken into employ and developed so as to serve the same purpose. Thus in many cases the upper tail-coverts have had to function as rectrices, with the result that very often it is difficult to tell them apart structurally from the true rectrices, while in one case, at least, the under tail-coverts have so completely assumed the rôle of the tail that they were generally regarded as true rectrices until it was discovered that the so-called tail-feathers were turned completely underside up!

I believe it is equally erroneous to assume that a structure so highly specialized as the "top-knot" of the California Partridge (*Lophortyx*) could be changed into the simple structure of the Mountain Partridge (*Oreortyx*), and while admitting the possibility of its disappearance and the development of the other feathers on the crown into a loose crest like that of the Scaled Partridge (*Callipepla*), I see no necessity for such an assumption, especially as the latter seems to show no apterium on the top of the head to account for the lost special tract. The more natural explanation seems to be to regard all these forms as having originated independently from more generalized types.

But apart from this last objection, which is one of detail, it will not do to turn Dr. Clark's trees upside down; they will not give us the true ascent of the genera, for the reason that he has assumed them to descend directly from the most generalized living form. He has not taken into account the fact that the genus among the extant forms, which in its totality shows the greatest amount of generalized characters, may have acquired one or more highly specialized peculiarities, thus showing that it is somewhat outside the direct line of ascent.

We shall now apply these principles in an attempt at reconstructing the genealogic tree of the North American partridges or quails, chiefly from the pterylographic characters.

In viewing these forms it seems thus evident that we have two groups, the members of which bear closer relationship to each other than to those of the other group. On the one hand, we have *Colinus* and *Cyrtonyx;* on the other, *Callipepla*, *Oreortyx*, and *Lophortyx*. The relationship of the former is obvious. The speckled-backed *Cyrtonyx* cannot well have developed through stages like those of the plain-backed *Lophortyx* and *Callipepla*, as suggested by Dr. Clark; and this character alone goes a long way to show the more generalized status of *Colinus* and *Cyrtonyx*. *Cyrtonyx*, with its higher developed crest, differentiated ventral feather-tract, reduced tail, and wanting claw to the thumb, is manifestly the more highly specialized form, thus leaving *Colinus* on the bottom round of the ladder. This is the same position given it by Dr. Clark it will be observed. The only difference between us is that he places it there because, among other generalized characters, it possesses 12 rectrices while I give it a similar place *in spite* of this fact. By placing it lower than *Callipepla*, with 14 rectrices, I suggest that while *Colinus* has already lost a pair, *Callipepla* is, on the whole, a more specialized form, in spite of the fact that it has retained the greater number of rectrices. If, therefore, the two groups of quail have a common origin, this ancestor is obviously below the line of the beginning of our tree, having in all probability a speckled plumage like *Colinus*, 14 rectrices and 16 secondaries.

Of the 3 members of the second group it is only necessary to say that *Callipepla*, with its 14 rectrices and loose crest, is the more generalized form, probably descended from an ancestor with 16 secondaries, by reduction to 14. From this ancestor *Oreortyx* ascended, on the one hand, by further specializing the crest, though retaining the 16 secondaries; while, on the other hand, *Lophortyx* lost two of the latter, besides assuming a still more complicated top-knot.

Assuming, then, the common origin of these genera, I substitute the following diagram as probably representing more nearly the true course of the development diagram of these forms.

The question of the genealogy of the North American *Tetraoninæ* is one greatly more complicated, for the reason that two of the genera apparently hold closer relationships to forms not occurring in this hemisphere than to the genera which are restricted to our continent.

Obviously *Bonasa*, with its partly naked tarsus, a very unusual thing in this group, stands apart from all the other American genera, and the fact that it has developed a special feather-tract on each side of the neck does not necessarily indicate any close relationship with *Tympanuchus*, much less that it has an origin in common with the latter. The general characters of *Lagopus* do not seem to imply a *special* relationship to *Canace*, and may only mean the greater lack of specialization of both and their comparative nearness to the common ancestor of all the grouse. *Centrocercus*, on the other hand, shows a number of extremely specialized characters alongside of the retention of generalized ones, and while it may share origin with *Pediocætes*,

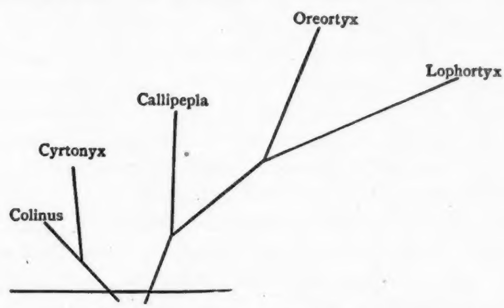


Diagram illustrating the possible development of the North American quail as divulged in their pterylographic characters.

there is no reason for believing that they have descended from *Canace*, which seems more closely allied to *Dendragapus* and *Tympanuchus* in spite of the specialization of the neck-tracts of the latter.

It is to be hoped that Dr. Clark may be able to carry his investigations on fresh material in this field farther, and especially that he may succeed in extending it to more forms of the so-called peristeropod Gallinæ, the Curassons and Guans, in Central and South America. He may then be able to point to more definite and trenchant characters between them and the alecteropods, in which connection I would call attention to the alleged presence of a "bastard secondary" in the latter and its absence in the former. The peristeropods are, on the whole, considered to be more generalized, but highly specialized pterylographic features are apparent in many forms — a feature which should not obscure the general proposition.

Leonhard Stejneger.

Gegenbaur's Comparative Anatomy of Vertebrates.[1]— For some years past rumors of a revised edition of Gegenbaur's *Vergleichende Anatomie* have been circulated by the European book-dealers, and even after the appearance of the masterly works of Lang, and of Korschelt and Heider, of Wiedersheim and of Hertwig, it must be confessed that the older text-book, if rewritten in the broad philosophical spirit that Gegenbaur accords to all his work, would have been no mean rival to the best that we have. Wisely or unwisely, Gegenbaur has not chosen to undertake the whole of this task, but has limited himself to a revision and expansion of only the vertebrate portion of his former text-book. The volume now published is about one-half of the new work, which even in its present state is more voluminous than the whole of the last edition of the *Comparative Anatomy*. The rest, we are told, is mostly written and may be expected within a year. When it is remembered that since the time of Owen no one perhaps has influenced the course of vertebrate comparative anatomy more profoundly than Gegenbaur, and that in the full strength of his years he now presents the results of a lifelong study, the monumental character of his work must be apparent.

The present volume contains nearly a thousand pages. After an introductory section the following systems of organs are treated: the integument, the skeleton, the muscular system, the nervous system, and the sense organs. The text is in two sizes of type, the smaller being reserved for less important topics. As a rule, most topics are followed by a brief list of the more important papers dealing with them. There is no index, but an extremely methodical arrangement and a detailed table of contents make this omission less noticeable. The text is illustrated by 619 figures, some of which are colored. The paper and presswork, while not the best, are uniformly good.

The new work is striking for the completeness with which the comparative method is applied. Thus, in the former editions, the integument of vertebrates was considered under three heads: the integument proper, epidermal structures, including glands, and the dermal skeleton. In Wiedersheim's *Lehrbuch*, which appeared some five years after Gegenbaur's last edition, a classification of the subject even to this slight extent was omitted, and the treatment of the integument lapsed into the purely descriptive form of a section on the integument of each group of vertebrates. In the new volume

[1] Gegenbaur, C. *Vergleichende Anatomie der Wirbelthiere mit Berücksichtigung der Wirbellosen.* Erster Band. Leipzig, W. Engelmann (1898), xiv + 978 pp., 619 figs.

Gegenbaur builds on his former arrangement: under the head of integument we find chapters on the epidermis, the corium, and the pigment; under organ-formation of the integument are placed in sequence horny structures, skin glands, mammary organs, scales and feathers, and hair; finally there is a chapter on the dermal skeleton. While this classification may not be ideal, it has the great advantage of bringing together those organs which are most likely to form natural series. It is obviously much more in accord with the traditions of comparative anatomy to consider, for instance, integumentary glands under one head than to scatter them through a descriptive account of the integument of different groups of vertebrates. In this respect Gegenbaur has made a positive advance, and the shortcomings which his system may eventually show will doubtless be found to have been the result of what is at present undiscovered rather than of any lack of appreciation on the part of Gegenbaur as to what the comparative method implies.

The volume is so replete with material which, if not exactly new, is at least first brought together in compact form, that it is practically impossible to review it in detail. It is interesting, however, to observe the position assumed by Gegenbaur on several important questions with which he has been closely associated in the past. Thus, on the relation of the marsupium to the mammary pockets he maintains his original opinion that these organs are essentially distinct, although Klaatsch has recently shown that it is quite possible that the marsupium has arisen by a fusion of mammary pockets. On the question of the origin of the lateral appendages Gegenbaur stoutly defends his original contention that these parts probably represent modified gill-arches, his general argument being that it is safer to assume that the lateral appendages have come from gill-arches about which we know something than it is to suppose them derived from a continuous lateral fin about which we know little or nothing. In matters of theory the volume is strikingly conservative, and this conservatism is in some respects an advantage. Thus, in the treatment of the cranial nerves the parts are fully and well described, but the account is not concluded with a tabulation in which some more or less imaginary segmental value is assigned to each nerve. In this respect Gegenbaur's treatment of the subject seems to us wisely out of style.

It would deservedly be a thankless task to point out the small inaccuracies which this, like all other books, contains. The omission of a pisiform bone from the carpus of the snapping turtle (p. 529),

and the description of the membrana tectoria as a cuticular structure (p. 890), may be contrary to fact, but they are blemishes which disappear in the marvelous wealth of accurate information which fills the whole work.

The place that the new *Anatomy* will find is not difficult to predict. Its size and fullness, together with the heaviness of Gegenbaur's style, will probably prevent it from being a popular text-book with most beginners, but its masterly qualities will make it an absolute necessity to every advanced student of vertebrate anatomy. In this respect it will occupy the field formerly held by Wiedersheim's *Lehrbuch*, though it seems to us unlikely that it will replace in any extensive way this author's *Grundriss*, which from its elementary character and simple language makes so satisfactory a book for the beginner.

The heavy debt which vertebrate anatomists already owe to Gegenbaur is materially increased by this accession to the list of best text-books, and it must be the wish of every one that circumstances may favor the early completion of a work destined to be so scholarly and valuable a contribution to the comparative anatomy of the vertebrates.

G. H. P.

The Natural History and Morphology of Dero vaga.[1] — This interesting little aquatic worm was described twenty years ago by Dr. Joseph Leidy[2] in this journal as *Aulophorus vagus*. It is found in shady places among vegetation in ponds and ditches, living by preference among masses of floating Lemna or among algæ on the bottom, shifting its position gradually from surface to bottom or *vice versa*, according to the location of food supply. Its food consists of vegetable matter, principally desmids, algæ, and even the fronds of Lemna. The worms inhabit cases which they construct of statoblasts, Arcella shells, the leaves of Lemna, etc. The cases of individuals living at the surface float, and those of individuals living at the bottom sink when the worms are removed. The period of sexual reproduction occurs during the first two weeks of July, when the body cavity posterior to the clitellum is crowded with eggs. Asexual reproduction by fission takes place throughout the year, but most rapidly during warm weather, when it may occur as often as

[1] Brode, H. S. A Contribution to the Morphology of Dero vaga, *Journ. of Morph.*, vol. xiv (1898), pp. 141–180, Pls. XIII–XVI.

[2] Leidy, J. Notice of Some Aquatic Worms of the Family Naids, *Am. Nat.*, vol. xiv (1880), pp. 421–425.

three times a week. Three fission zones have been observed in one individual at the same time. As the animal grows in length, the case which it inhabits is extended, and after fission the two daughter-worms divide it by placing their heads together at its middle and forcibly breaking it; each worm then swims away with one-half of the old case. The fission zone is formed near the middle of some segment, usually back of XVII and in front of XXII. The new head and tail are almost completely formed before separation takes place. The number of somites in the new head is constant, being five, while twelve to sixteen segments are visible in the tail before a second fission begins. Worms divided by cutting regenerate the missing part, though only enough segments are regenerated at the anterior end to complete the cephalized portion, *i.e.*, the first five. Thus if two are removed but two regenerate, while if seven are taken away only five new segments are formed. At least three or four segments in addition to the five in the cephalic region are necessary for the regeneration of the tail. Dr. Brode gives a detailed account of the structure of the body wall, of the nervous system, and of the sense organs. Each segment is provided with four lateral nerves which arise from the ventral ganglion and pass to the body wall and thence dorsally. The epidermis is provided with a remarkable series of sense organs, each segment bearing two series arranged in greater and lesser circular bands of twelve and eight organs respectively. These organs are so spaced as to form twenty longitudinal rows extending the whole length of the body. Dr. Brode also confirms Hesse's view that the so-called lateral line of oligochetes is formed by the accumulation of the nucleated plasma portions of the circular muscle fibres and cannot, therefore, be interpreted as a nervous structure. The epidermal sense organs have no share in the formation of this line. The marked serial symmetry of the epidermal sense organs and lateral nerves is held by the author to support the colonial theory of the origin of metamerism.

C. A. K.

Crustacea of Florida and the Bahamas. — Miss Mary J. Rathbun is an indefatigable student of Crustacea. In fact, the mantles of Stimpson, Smith, Kingsley, Say, Gill, Gibbes, and all other past students of the group appear to have fallen on her shoulders. In the paper before us she describes the 127 species of brachyma, collected by the Iowa University Expedition of 1893.[1] Several new

[1] *Bulletin of the Laboratories of Natural History of Iowa University*, June, 1898.

species are described, and there are notes on others not so well known. As in all of Miss Rathbun's work, the recognition of salient characters is acute, and their expression is put in concise form. One or two features which persistently reappear in her writings seem to call for criticism. Apparently the attempt is made to arrange the species on a descending scale, for the series begins with the Maioids and ends with the Calappoids, but certainly the Ocypodoids are the highest of the Decapods. The other feature of which we would complain is the foundation of new genera (*e.g.*, Eupanopens) upon characters of far less than generic value. Certainly the characters given in the following diagnosis are not of generic value. Carapace of moderate width, anteriorly subquadrate, crossed by broken transverse lines; frontal lobes sinuous; five distinct lateral teeth, the third, fourth, and fifth prominent, the second usually so. One feature of the collection is interesting — the absence of any specimens of Gelasimus.

Entomostraca of Karelia. — An extended faunistic study of the Entomostraca of Karelia in the region tributary to the White Sea has been made by Dr. K. E. Stenroos.[1] Especial attention was given to the Cladocera, of which 64 forms — an exceptionally large number — were found. Species are grouped as littoral or limnetic, though a few are members of both faunas and exhibit marked differences according to their environment. When found alongshore or in weedy shallows of the lakes they are opaque and brownish, while in open water they have the hyaline appearance characteristic of the typical limnetic fauna. Great variation was observed within the genus Bosmina, almost every body of water showing its own peculiar type. Wherever adjacent lakes presented similar physical characteristics the Bosminidæ found therein were much alike, but the more diverse the environment, the greater the unlikeness of the Bosmina fauna. Intermediate forms were found which seem to render necessary a considerable reduction in the number of species hitherto recognized in this genus. *Chydorus rugulosus* Forbes, originally described from Lake Superior, is reported from Finnish waters. C. A. K.

Notes. — The interesting amphibian, *Amphiuma means*, is reported by H. M. Smith in the *Proc. of the Nat. Museum*, Vol. XXI, as occurring in the vicinity of Hampton, Virginia, where it was found in some

[1] Stenroos, K. E. Zur Kenntniss der Crustaceen-Fauna von Russisch-Karelien, *Acta Soc. pro Fauna et Flora Fenn.*, Bd. xv.

numbers by workmen while excavating for an electric railroad. This extends the distribution of the species by some 110 miles to the northeast, the furthest station previously recorded in this direction being, according to the National Museum collections, Tarboro, North Carolina.

Number 4 of the eighth volume of the *Journal of Comparative Neurology* contains, beside the usual literary notices, the conclusion of Dr. Adolf Meyer's Critical Review of the Data and General Methods and Deductions of Modern Neurology, and Professor H. H. Donaldson's Observations on the Weight and Length of the Central Nervous System and of the Legs in Bullfrogs of Different Sizes.

Number 3 of the second volume of the *Zoölogical Bulletin*, issued in December of the past year, contains Notes on the Finer Structure of the Nervous System of Cynthia partita, by G. W. Hunter, Jr.; The Maxillary and Mandibular Breathing Valves of Teleost Fishes, by U. Dahlgren; The Effect of Temperature on the Regeneration of Hydra, by F. Peebles; and Further Notes on the Egg of Allolobophora fœtida, by K. Foot and E. C. Strobell.

Dr. Arthur Willey describes a new Peripatus from New Britain, but very distantly related to any of the previously known species, which is placed in a new subgenus, Paraperipatus. Dr. W. M. Wheeler describes *P. eiseni* (*Journ. Morph.*, Vol. XV, p. 1), from Mexico.

BOTANY.

Some Recent Elementary Text-Books. — No two teachers present a subject in the same manner, and to attempt to compel them to do so, as is done in some public school systems, usually makes automata of them and machines of their pupils, when nature work is involved. But the yearning of every good teacher for some reference book that he can put in the hands of his class, giving them what he cares to have them know and freeing them from the expense of paying for other matter, seems scarcely capable of expression otherwise than in the preparation of a text-book of his own. Four such books have recently come to hand, one quite elementary, the others aiming at the work done in the secondary schools or by the most general of college classes.

Professor Bailey,[1] with a horticulturist's bias, most admirably teaches both pupil and teachers how to study twigs and buds, leaves and foliage, flowers, fructification, propagation, the behaviors and habits of plants, and the kinds of plants — to which he adds suggestive paragraphs on pedagogical methods, books, classification, evolution, and the interpretation of nature and the growing of plants. Nothing could be better in its way — and it is a very good way — than this addition to the products of the pen of a versatile and prolific writer.

Professor Barnes,[2] from the point of view of the physiologist, attempts to exhibit to pupils 13 to 18 years of age, who are engaged in genuine laboratory study, the variety and progressive complexity of the vegetative body, to explain the unity of plan in both the structure and action of the reproductive organs, and to give an outline of the more striking ways in which plants adapt themselves to the world about them. It is to be feared that he has aimed over their heads.

Professor Atkinson,[3] perhaps with less leaning toward any one side, gives fourteen chapters to physiology, twenty-one to morphology, eight to lessons on plant families, and thirteen to ecology.

Each of these books is good. If one could have only one of them, he would probably choose the first or the last noticed, which happen to come from the same faculty — that of Cornell University. But the point of view is so different that whichever he had, he would wish to complement it with the other — or to write his own book. T.

Rhodora[4] is the euphonious title of a new journal, started with the current year, by the New England Botanical Club. It is well gotten up, and under the editorship of Dr. B. L. Robinson, of the Gray Herbarium of Harvard University, it is sure to be well conducted. The initial number contains the following articles: Fernald, Rattle-

[1] Bailey, L. H. *Lessons with Plants.* New York, The Macmillan Company, 1898. Pp. xxxi + 491, 446 ff. — *First Lessons with Plants*, being an abridgment of *Lessons with Plants.* New York, The Macmillan Company, 1898. Pp. x + 117, 116 ff.

[2] Barnes, C. R. *Plant Life Considered with Especial Reference to Form and Function.* New York, Henry Holt & Company, 1898. Pp. x + 428, 415 ff.

[3] Atkinson, G. F. *Elementary Botany.* New York, Henry Holt & Company, 1898. Pp. xxiii + 444, 509 ff.

[4] *Rhodora*, Journal of the New England Botanical Club. Price, $1.00 per year ($1.25 to all foreign countries, except Canada). Editorial communications to be addressed to B. L. Robinson, 42 Shepard Street, Cambridge, Mass. Subscriptions, etc., to W. P. Rich, 3 North Market St., Boston, Mass.

snake-plantains of New England; Brainerd, Saniculas of western Vermont; Collins, Notes on algæ, 1; Deane, A prolific gentian; Williams, Myosotis collina in New England; Robinson, A new wild lettuce (*L. Morssii*) from Massachusetts; Webster, Notes on some fleshy fungi found near Boston; Manning, Matricaria discoidea in eastern Massachusetts.

The Gametophyte of Botrychium virginianum.[1]—Until this publication of Mr. Jeffrey our knowledge of the development of the embryo of Botrychium was practically none, and the previous accounts of the prothallus have been very insufficient. The material used in his investigation was gathered in its natural habitat — a sphagnum bog in which he found an abundance of prothalli in all stages. Owing to the extreme delicacy of the objects, great difficulty was experienced in mining them into paraffin. An ingenious dialyzer rotated by clock-work was employed to insure the more gradual yet sufficiently rapid osmosis between the benzole and the alcohol.

The gametophyte of *B. virginianum* is subterranean and without chlorophyll, and harbors a fungus of a phycomycetous type which the author regards as possibly symbiotic with the prothallus. On the gametophyte, which is oval in shape and beset with rhizoids, are borne both the antheridia and archegonia. The former above the latter on the sides. The antheridia, which develop from a single superficial cell, possess a double outer wall like those of other Ophioglossaceæ known, and the antherozoids are of the usual type of the Filicineæ. The archegonium is somewhat less elaborate than that of the typical fern, and it is to be noticed that the canal cell while binucleate does not show any division of its protoplast. In the development of the egg-cell the usual divisions forming the octants are seen, but the walls of the latter soon lose their identity and the embryo is relatively many-celled before the organs appear. The root, shoot, and cotyledon originate from the upper part of the embryo— *i.e.*, probably the upper octants. The cotyledon is apparently a secondary formation in the region of the shoot. The foot which is large arises from the whole lower portion of the embryo. The growing region of the root, shoot, and cotyledon is in each case a single apical cell. The root develops most rapidly at first, followed by the cotyledon, a reversal of the condition found in *Ophioglossum pedunculosum*

[1] Jeffrey, E. C. The Gametophyte of Botrychium virginianum, *Trans. Canad. Inst.* (1896–97). Reprinted for University of Toronto Studies (1898), *Biol. Series*, No. 1.

losum. But in other respects the gametophyte and embryo of *B. virginianum* agrees with what is known of other Ophioglossaceæ. The author points out a similarity in form between the prothalli of *B. virginianum* and *Hycopodium annotinum*, while a likeness is also found in the same organs of *Ophioglossum pedunculosum* and *L. cernuuem* and *L. inundatum*, showing two types of the gametophyte in the Ophioglossaceæ as in the Lycopodineæ.

H. M. R.

Proteolytic Enzyme of Nepenthes.[1]—This paper is in continuation of one published by the same author in 1897. He concludes that the enzyme from the pitchers of Nepenthes is comparatively a very stable one. High temperatures and alkalis gradually lessen its activity, but do not completely destroy its power of digestion unless strong means are employed. The enzyme is of the nature of a tryptic ferment closely resembling that found in germinating seeds, like which it is active only in an acid medium. The author considers that he has fairly demonstrated the enzyme to arise from a zymogen in the gland cell of the pitcher.

H. M. R.

Nucleus of the Yeast Plant.[2]—According to this last account the cells of yeast certainly possess what the author terms a nuclear apparatus. This consists in the early stages of fermentation of what is called a homogeneous nucleolus in close contact with a vacuole containing a chromatin network. In later stages the "chromatin-vacuole" may have disappeared, the chromatin material being found as fine granules in the protoplasm. In the young stages there may be more than one "chromatin-vacuole," which later appear to fuse. The division which accompanies budding is direct, and takes place in the constriction between mother and daughter cell. If the author is properly understood, in spore formation the chromatin is absorbed by the nucleolus, to appear later in the form of fine grains (chromosomes ?). The nucleolus elongates into a dumb-bell shape in the division preceding spore formation, and then constricts into two. Subsequent divisions forming four or even more new nucleoli may take place. A wall forms around these, and the spores are formed. The author does not demonstrate very definitely the relation of the nuclear apparatus of the spore to that of the vegetative cell. It

[1] Vines, S. H. The Proteolytic Enzyme of Nepenthes (II), *Ann. Bot.*, vol. xii (December, 1898), pp. 545-555.

[2] Wager, Harold. The Nucleus of the Yeast Plant, *Ann. Bot.*, vol. xii (December, 1898), pp. 499-537, Pls. XXIX, XXX.

would be interesting to know the changes which take place in the subsequent growth of the spore. A full historical account precedes the paper. Corrosive sublimate and Gram's iodine solution are recommended for killing, while a variety of aniline dyes were chiefly used for staining. Sections were also made. The species studied are given as *Saccharomyces cerevisiæ*, *S. ludwigii*, *S. pastorianus*, *S. mycodenua*, and a red yeast.

H. M. R.

Botanical Notes. — Skeletonizing leaves, always an interesting occupation, and one of some scientific utility, is described in the number of *Science* for December 30 by A. F. Woods, who finds minute crustacea belonging to the genus Cypridopsis to be the active agent. So long as any parenchyma is present, they appear not to attack even the finer vascular bundles.

Under the heading "Foreign Weeds and their Extermination," Professor Pammel contributes an interesting little article to *The Gentleman Farmer Magazine* for November.

The forage plants and forage resources of the Gulf States are reported on by Professor Tracy in *Bulletin No. 15* of the Division of Agrostology of the United States Department of Agriculture.

Forestry in relation to physical geography and engineering is the subject of an article by John Gifford in the *Journal of the Franklin Institute* of July last.

"Check-List of the Forest Trees of the United States, their Names and Ranges," is the title of *Bulletin No. 17* of the Division of Forestry of the United States Department of Agriculture, by George B. Sudworth. It is stated to be in the main a condensed reproduction of *Bulletin No. 14* of the same division, like which it exemplifies the "Neo-American" views in nomenclature, and it is intended to be helpful in bringing about a more uniform and stable use of names by lumbermen, nurserymen, and others interested in forest trees.

The determination of woods by characters drawn from their structure, to which some attention has been given by engineers of late, forms the subject of an article by Charles Bommer, illustrated by twelve enlarged phototypes, showing the cross-section of as many woods, in the *Bulletin of the Société centrale Forestière* of Belgium for December.

Prof. T. H. McBride has published in separate form an instructive address on public parks for Iowa towns, which may well be read by the inhabitants of towns outside that state.

A provisional enumeration of the species of Cerastium is published by F. N. Williams in the *Bulletin de l'Herbier Boissier* of November 15.

The early botanical views of *Prunus domestica* are discussed by Prof. F. A. Waugh in the *Botanical Gazette* for December.

Whipplea Utahensis Watson is made the type of a new genus, Fendlerella, by A. A. Heller in the *Bulletin of the Torrey Botanical Club* for December, in which number he also makes of *Actinella Bigelovii* Gray the type of a new genus, Macdougalia.

The cockle-bur, *Xanthium strumarium*, which has been introduced into Queensland, is stated by F. M. Bailey, in the *Queensland Agricultural Journal* for November, to be poisonous to cattle, the effect being "to paralyze the heart, induce torpor, and cause death without pain or struggle."

The *Revue Horticole* of December 1 contains good figures of several of the forms into which *Dodecatheon Meadia* has passed in cultivation.

Fritillaria pluriflora of California is well figured in the *Botanical Magazine* for December.

Under the title *Mycological Notes*, Mr. C. G. Lloyd, of Cincinnati, began in November the issue of occasional bulletins on the fungi in his collection.

Sydow's *Deutscher Botaniker-Kalender für 1899* (Berlin, Borntraeger), is a handy little pocketbook which, among other things, tells under each day of some botanist who was born or died on that day of the month, gives a list of exsiccatæ of cryptogams, lists of botanic gardens and natural history museums of the world and of their principal plant collections, and the now familiar nomenclature rules of the Botanic Garden of Berlin.

The Plant World for December maintains the happy character of the journal for short botanical articles of general interest.

Vol. II of the *Annuaire du Conservatoire & du Jardin Botaniques de Genève*, in addition to a report on the establishment and lists of seeds collected, contains an important paper on the geographical limitation of species by the late Alphonse de Candolle, and systematic papers by Briquet, Lindau, Hochreutiner, and Casimir de Candolle.

The fourteenth volume of the *Acta Societatis pro Fauna et Flora Fennica* is entirely botanical: Wainio, *Monographia Cladoniarum Uni-*

versalis, III; Elfving, *Anteckningar om Kulturväxterna i Finland;* Mela, *Nymphæa Fennica, eine neue europäische Seerose.*

The *Ottawa Naturalist* for December contains No. 12 of the "Contributions to Canadian Botany," by James M. Macoun.

"Camping in Florida," a little article by Professor Hitchcock from *The Industrialist* (of the Kansas State Agricultural College) for November, tells how he contrived a wheelbarrow with pneumatic tire and ball bearings, on which he trundled the necessary outfit of a botanist 242 miles in 24 consecutive days, his expenses averaging 30 cents a day.

No. 15 of Dr. Small's "Studies in the Botany of the Southeastern United States," in the December number of the *Bulletin of the Torrey Botanical Club*, contains a rich grist of new species, especially in the genera Smilax, Oxalis, and Euphorbia.

The October number of *Monatsschrift für Kakteenkunde* contains a short note by Purpus on his season's botanizing in our western district.

Under the title "New Species of Plants from Mexico," Mr. Brandegee publishes several new binomials in *Erythea* for January.

PALEONTOLOGY.

Cretaceous Foraminifera of New Jersey.[1] — American literature is conspicuously deficient in works relating to the fossil Foraminifera, although in Europe the class has received the attention of some of the leading paleontologists, and their monographs and special reports cover the investigations of many years.

The present memoir includes the cretaceous Foraminifera from the marl beds of New Jersey, embracing the Monmouth, Rancocas, and Manasquan formations. The greatest number of species (seventy-nine) occurs in a limestone layer in the Rancocas formation. Four species are common to all four marl beds. Altogether there are one hundred and fifteen species now known from the New Jersey Cretaceans. The plates give unusually good representations of the form and structure of about thirty species of special interest. C. E. B.

[1] Bragg, R. M., Jr. The Cretaceous Foraminifera of New Jersey, *Bull. U.S. Geol. Surv., No. 88.* 8vo. 6 plates, 89 pp. Washington, 1898.

Cretaceous and Tertiary Plants.[1] — Botanists who are engaged in studying the plants of the Cretaceous and Tertiary formations will fully appreciate the service rendered by Professor Knowlton's latest contribution in the form of a catalogue of these plants, which have always had a special interest because of their often close connection with the flora of our own time. The catalogue possesses double value in that it not only records most of the species so far discovered, but includes also a full and valuable bibliography of the subject. It gives striking evidence of the very rapid growth of our knowledge of this flora during the past twenty years, a fact which becomes all the more apparent when we observe that a number of new species have been recorded since its issue.

Miocene Flora.[2] — In recent studies of the Miocene plants as found at Idaho City, Idaho ("Payette formation"), Professor Knowlton enumerates twenty-nine species, of which 59 per cent are recognized as new.

Permian Flora.[3] — One of the richest and most interesting deposits of Permian plants in France is to be found at Lodève, where the slates have supplied material which has been studied by Brongniart and others since 1830. Zeiller now reviews all the available material, and is enabled to announce the addition of six new species, of which five belong to the genus Callipteris.

Cretaceous Cycads.[4] — Within the last five years there has been brought together a somewhat remarkable collection of Cycads from the cretaceous formation of the Black Hills. They number 155 specimens of trunks in various states of completeness and preservation, and belong chiefly to Yale University. This material has been studied by Prof. Lester F. Ward, who finds that among different species the height varies from 12 cm. to 130 cm., the diameter from 4 cm. to 75 cm., and that in most cases they represent a type of

[1] Knowlton, Frank Hall. A Catalogue of the Cretaceous and Tertiary Plants of North America, *Bull. U. S. Geol. Surv.*, 1898.

[2] Knowlton, Frank Hall. Report on the Fossil Plants of the Payette Formation, *Eighteenth Annual Report U. S. Geol. Surv.* (1896–97), Pt. iii, p. 721.

[3] Zeiller, M. R. Contribution à l'étude de la flore ptéridologique des schistes permiens de Lodève, *Bull. Mus. Marseilles* (1898), Pt. i, vol. i, p. 9.

[4] Ward, Lester F. Descriptions of the Species of Cycadoidea, or Fossil Cycadean Trunks thus far Determined from the Lower Cretaceous Rim of the Black Hills, *Proc. U. S. Nat. Mus.*, vol. xxi (1898), pp. 195–229.

comparatively low form, in which the stem is commonly as broad as high. Of twenty-one species distinguished all but one are new.

D. P. P.

GEOLOGY.

Maryland Geological Survey. — The two handsome volumes, of which the second has quite recently been issued, representing the first publications of the Maryland Geological Survey,[1] under the direction of Prof. William Bullock Clark of Johns Hopkins University, are a credit to the Maryland Commission, and show clearly the advantage enjoyed by the Maryland geologists in their proximity to the offices of the federal Survey at Washington, and in their immediate association with the scholarship of Johns Hopkins University. A cursory examination of these volumes shows that the functions of a State Survey for the people of the state, in giving to them accurate information concerning maps, economic products, and topographic advantages, are distinct from those of the federal Survey, while at the same time it is very evident that coöperation with the United States Geological Survey is essential to such work. In the establishment of this Survey the legislature acted wisely in appointing the presidents of the two leading colleges members of the Commission; and the eleventh Resolution of the Commission, asking official coöperation from the head of the United States Geological Survey and from the directors of the geological surveys in neighboring states, has had much to do with the high grade of work shown by the Survey's first publication. For the execution of this work unstinted praise is due to Professor Clark and his assistant, Dr. Mathews.

In the first volume, "issued to set forth the organization of the Survey, and to show what has hitherto been done in the study of the geology, natural history, and resources of Maryland," the plan of operation of the Survey is stated concisely; a very complete statement of the physiography, geology, and mineral resources of Maryland has been compiled by Professor Clark, with a most scholarly historical sketch of earlier investigations. Dr. Mathews contributes a bibliography and cartography of Maryland, which is one of the most complete of its kind that we have seen. It is arranged in chronological order, and includes works from 1526 to 1896 inclusive,

[1] *Maryland Geological Survey*, vol. i (1897), 539 pp.; vol. ii (1898), 509 pp., plates and maps. Baltimore, The Johns Hopkins Press, 1897–98.

with a brief summary of each work. L. A. Bauer contributes a chapter on magnetic work, with a preliminary isogonic map of the state. In addition to the usual study of economic products, the plan of the Survey embraces a special investigation of road materials, of artesian well prospects, of water power, and of the physiographic features of the state. A geological map of the state, published in coöperation with the United States Survey, is incorporated in the volume, with also many photographic illustrations, a view of the topographic model of Maryland, index maps showing the progress of work of the United States Survey, and a hypsometric map.

The second volume is even more attractive than the first, the half-tone illustrations being supplemented by numerous photogravures on heavy paper, and colored plates showing the intimate structure of polished slabs of building stone which are, in the opinion of the reviewer, the most perfect reproductions of natural rock surface that have ever been made. Especially remarkable is Plate II, a granite porphyry from Ellicott City, in which even the cleavage fractures on the surface of the feldspar crystals and the semi-transparent appearance of the fracture edges are portrayed with perfect accuracy both as to color and form. After the administrative report of the superintendent, this volume contains a full account of Maryland building stones, by Dr. Mathews, with an introductory chapter on the physical, chemical, and economic properties of building stones, including methods of testing, by George P. Merrill. Dr. Mathews's work appears again in the third part of the report, in an exhaustive historical review of the maps and map-makers of Maryland. It is in these historical chapters that the first volumes of the Maryland Survey especially excel, and in them is shown the advantage of the extensive library facilities of Baltimore and Washington. Henry Gannett, of the United States Geological Survey, contributes a summary of the aims and methods of modern cartography, giving from his wide experience a systematic account of the object of the modern topographic map, the methods employed to-day in the government office, and figures and formulæ illustrating the use of instruments. This chapter by itself is of great value in giving to the public a statement of the latest methods of topographical surveying, with excellent photographic illustrations of the several instruments employed.

The second volume shows the success of the first efforts of the State Survey in impressing on the people of the state the value of its work, in that the General Assembly of 1898 passed special bills appropriating money for the extension of the topographic survey

and for the investigation of scientific methods of highway construction, following the lead, in this last respect, of the State of Massachusetts.

T. A. JAGGAR, JR.

PETROGRAPHY.

Granites and Diabases. — Milch's[1] article on the granitic rocks of the Riesengebirge and Bodmer-Beder's[2] paper on the olivin diabase from the Plessurgebirge in the Grisons are monographic presentations of the subjects they discuss. In the first, the author describes in great detail, and with a wealth of chemical analyses, the well-known granitite of the Riesengebirge, together with its basic and acid phases and the concretions they contain. Chemically, the rock is a mixture of Rosenbusch's granitic and dioritic magmas. The acid and basic phases are regarded as differentiation products of the magma that yielded the normal rock. Even the dike granites and the pegmatites of the district are looked upon as "Schlieren" in the granitic magma, formed by the solidification of the mother liquor left after the greater portion of the magma had crystallized. The basic phases of the rock often present the features of kersantites. They appear as concretions in the granitite and as dark "Schlieren" traversing it.

The diabases of the Plessurgebirge in the neighborhood of Chur occur as stocks, as horizontal sheets, and as dikes in the predominant limestone. In the center of the stocks its structure is granular; nearer the peripheries of the masses it is ophitic, and on the peripheries it is vitrophyric. Varioles and vacuoles are present as contact phenomena. The former are spherulites of radial plagioclase, and the latter amygdaloidal cavities that have been filled with albite, quartz, and calcite. The rocks present no unusual features, but the paper is worth examination because of its thoroughness in describing and picturing each structural form of the rock investigated and of its constituents.

Granitic Oceanic Islands and the Nature of Laterite. — The small group of tropical oceanic islands, known as the Seychelles, are noteworthy from the fact that they are neither of coral nor of volcanic origin, but are granitic in character. Bauer[3] reports that they consist principally of granites, and syenites cut by dikes and covered

[1] *Neues Jahrb. f. Min.*, Bd. xii, p. 115. [2] *Ibid.*, p. 238.
[3] *Neues Jahrb. f. Min.*, etc. Bd. ii (1898), p. 163.

in places by flows of felsite-porphyry, granite-porphyry, syenite-porphyry, hornblende-vogesite, diorites, diabase, and augite-porphyrite. The greatest interest of the paper lies in the discussion of the nature of the weathering product, laterite, which here, as in other tropical lands, constitutes so large a part of the rock covering. In the Seychelles this material results from the decomposition of both acid and basic rocks, but it is best developed in connection with the granite, bowlders of which may consist of the fresh rock in the center and laterite on the exterior, with a complete series of gradation forms between. The typical laterite is a red, brown, or yellow mass that may be dense and hard, clay-like, or sandy and friable under different conditions. Often this substance may be mixed with quartz grains or mica scales. In thin section it is sometimes nearly opaque, sometimes completely transparent. Everything but the quartz of the granites and the ilmenite of basic rocks has been changed to a light-colored, scaly aggregate of doubly refracting plates colored in places by iron oxides and other compounds. Analyses of this substance from granite and diorite yield: 60.68% Al_2O_3, 9.56% Fe_2O_3, and 29.76% H_2O for granite-laterite, and 51.98% Al_2O_3, 20.95% Fe_2O_3, and 27.07% H_2O for diorite-laterite.

Laterite is thus very different from clay; in composition it is much more like hydrargillite. The beauxite of the Vogelsberg and other supposed beauxites derived from basalts are of the same nature. In all cases the laterite is the residue left by leaching agents in a tropical climate. The occurrence of the beauxite at Vogelsberg indicates to the author the existence of a warm climate over this place at the time the beauxite was formed.

Isenite and Intermediate Types of Volcanic Rocks. — In the Westerwald, in the province of Hesse-Nassau, basalts, trachytes, andesites, and phonolites are well developed in many different phases, especially in the transition forms that have recently attracted so much attention among petrographers. The predominant andesite, for instance, is a transition phase between andesite and trachyte; some of the other andesites are basaltic in habit, and a few of the trachytes are phonolitic. Dannenberg[1] describes all these types in detail, and adds analyses of many of them. The "isenite" from Sengelberg, Kramberg, and Himmrich consists of a groundmass made up of lath-shaped plagioclases, and small grains of augite and of olivine, magnetite, and some secondary substances, and pheno-

[1] *Min. u. Petrog. Mitth.*, Bd. xvii, pp. 301, 421.

crysts of plagioclase, augite, and opacitic pseudomorphs of hornblende. The porphyritic plagioclase occupies about half the mass of the rock. Like the feldspar of the groundmass, it is a basic labradorite. The rock is thus a hornblende-andesite.

Dike Rocks of Portland, Me. — Lord[1] maps and briefly describes the basic and acid dikes that cut the schists in Casco Bay and on Point Elizabeth, Portland, Me. The basic dikes are nearly all porphyritic. In composition they are olivinitic and enstatitic diabases, and camptonites. The acid ones are pegmatites and aplites. The rock called camptonite is composed of porphyritic olivines and augites in a groundmass consisting of idiomorphic brown hornblende, anorthoclase, magnetite, and secondary products. The hornblende is in small prisms, some of which contain remnants of augite, and therefore are believed to be paramorphic. The anorthoclase is in lath-shaped crystals arranged radially. Analyses of the anorthoclase (I) and the camptonite (II) follow :

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	Na_2O	K_2O	H_2O	Total
I.	57.34		20.79	2.88		4.27	.16	8.09	4.17	2.66	= 100.36
II.	45.20	.68	17.12	5.98	6.55	7.89	5.29	4.23	2.13	5.53	= 100.60

In the course of his work the author separated the hornblende from the camptonite of Campton Falls, N. H., and subjected it to analysis with this result :

SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	Na_2O	K_2O	Total
37.80	4.54	12.89	6.14	12.55	13.64	4.10	5.26	3.24	= 100.16

Notes. — A biotite-tinguaite dike cuts through the augite-syenite of Gales rocks, Manchester, Essex County, Mass. According to Eakle,[2] the structure of the rock differs from that of a typical tinguaite in that the feldspar and aegirine are in lath-shaped and prismatic crystals rather than in the acicular forms characteristic of this rock. In this respect it resembles sölvsbergite. The composition is :

SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MuO	CaO	MgO	K_2O	Na_2O	H_2O at 110°	H_2O	Cl	Total
60.05	.11	19.97	4.32	1.04	.79	.91	.23	3.24	7.69	.15	1.26	.28	= 100.04

Oetling[3] has made a number of experiments to determine the effect of various conditions on the manner of crystallization of rock magmas, and has incorporated his results in an article full of interesting comments on his experimental methods and suggestions for future work on the subject.

[1] *Amer. Geol.*, vol. xxii, p. 335.
[2] *Amer. Journ. Sci.*, vol. vi (1898), p. 489.
[3] *Min. u. Petrog. Mitth.*, Bd. xvii, p. 331.

NEWS.

From the January number of the *Geographical Magazine* we learn that the Dutch government has placed at the disposal of the scientific men of Holland the newly built warship *Siboga*, of 820 tons, for the deep-sea exploration of the East India Archipelago. The vessel is fitted out with the Le Blanc sounding apparatus, a Lucas sounding machine, and an electric cable drum with a capacity of 10 kilometers of steel cable, and a zoological equipment for plankton, littoral, and deep-sea investigations, including deep-sea nets of the Chun, Tanner, and Fowler types. The cost of the expedition is met partly by the government and partly by learned societies and private individuals. The scientific leader of the expedition is Professor Max Weber, assisted by Dr. J. Versleys, Mr. H. Nierstrasz, and Dr. A. H. Schmidt. The object of the expedition is the zoological, botanical, and physical investigation of the marine area of the East Indian Archipelago, particularly of the deep basins of its eastern portion. The work of the expedition is expected to extend over two years.

The Macmillan Company has begun the publication of a new bi-monthly magazine, *Bird-Lore*, for observers of birds, under the above title. Mr. Frank M. Chapman is the editor of the paper, which is the official organ of the Audubon societies. Almost all the principal workers on birds out-of-doors will contribute during the year. Photographic reproductions of wild birds in their haunts will form a prominent feature.

The *Proceedings of the American Association for the Advancement of Science* has been issued this year with a promptness which is as gratifying as it is novel.

The German Anatomische Gesellschaft meets this year in Tübingen, May 22 to 25.

The Liverpool Museum is to have an addition measuring 162 by 190 feet, five stories in height. The three lower floors are for the technical schools, the two upper will afford galleries of horseshoe shape, the lower for invertebrates, the upper for vertebrates.

One cannot repress the feeling, as he looks over the reports of the various conferences on the bibliography of scientific literature, that

the committees are building an unwieldy machine with its central and regional bureaux.

The Boston Society of Natural History is trying to increase its membership. Reduction in the rate of interest of its invested funds threatens seriously to impair its usefulness unless the loss be made good in other ways.

Ever since his appointment as scientific director of the U. S. Fish Commission, Dr. H. C. Bumpus has been publishing notes on the breeding habits of animals at Woods Holl. It is to be hoped that the author will collect these notes, arrange them in systematic order, and reissue them as a whole, thus making them more useful to students.

The City Library Association of Springfield, Mass., will hold this month an exhibition of material relating to geography and geology, to show chiefly the results of geographical and geological research during the last few years. Methods of teaching geography and geology will form one of the chief features of the exhibition, which will also demonstrate, as far as possible, the progress of these sciences by the display of published results.

Professor A. S. Packard, of Brown University, sailed the first of the year for the Mediterranean. He will spend the winter in Egypt, Palestine, and other countries bordering on the Mediterranean, and later go to France to obtain materials for a proposed life of Lamarck.

The refusal of the leaders of the Geological Society of America to affiliate in any way with the other scientific societies which meet during the holidays may have some good reason behind it, but we have never heard of it. During the meetings of 1898 this isolation caused some complaint on the part of some of the geologists, for they were unable to obtain the reduced rates on the railroads which were enjoyed by the members of the other societies.

It seems probable that the Society of Naturalists, with its associated organizations of morphologists, botanists, anatomists, psychologists, etc., will meet in 1899 in New Haven.

The Paris Academy of Sciences has awarded half of the Lallemand prize to Mr. E. P. Allis for his memoir upon the head of Amia.

We chronicled some time ago the appointment of Dr. Slingerland as state entomologist of New York. It appears that there is a conflict in the laws as to the appointing power; this being given in one place to the governor, in another to the regents of the university.

We learn that Mr. Slingerland has no desire to enter into any contest for the position, and the appointment of Mr. E. P. Felt will probably hold. Cornell University is certainly to be congratulated in retaining the services of Dr. Slingerland.

The following persons have been elected to honorary membership in the Nebraska Academy of Sciences: Alexander Agassiz, LL.D.; John M. Coulter, LL.D.; Professor Samuel H. Scudder; Joseph Le Conte, LL.D.; Simon Newcomb, LL.D.; Dr. Otto Kunze; Professor Victor Hensen.

Professor O. C. Marsh, of Yale University, has recently been elected correspondent of the Academy of Sciences of Paris.

Appointments: Dr. John M. Clarke, state paleontologist of New York. — H. H. Dale, Coutts-Trotter student in zoology in Trinity College, Cambridge. — Wallace Craig, assistant in the Illinois state laboratory of natural history. — C. B. Crampton, of Edinburgh, assistant keeper of the geological department of the Manchester Museum. — Dr. Eugen Dubois, professor of geology in the University of Amsterdam. — Dr. E. P. Felt, state entomologist of New York. — Dr. Lepetet, professor of histology in the faculty of sciences at Clermont, France. — Dr. F. J. H. Merrill, state geologist of New York. — Dr. Heinrich Obersteiner, professor of physiology and pathology of the central nervous system in the University of Vienna. — Dr. Domenico Saccardo, assistant in the botanical gardens at Bologna. — M. Camille Sauvageau, professor of botany in the University of Dijon, France. — Mr. W. G. Savage, assistant in bacteriology in University College, London. — Giulio Valentia, of Perugia, professor of anatomy in the University of Bologna. — Dr. Weinschenk, privat docent in mineralogy and geology in the Munich Polytechnicum. — C. W. Young, assistant in botany in the University of Illinois. — Dr. K. W. Zimmermann, professor extraordinarius of anatomy in the University of Bern. — Dr. Oskar Zoth, professor of physiology in the University of Graz.

Deaths: Joseph Gibelli, professor of botany in the University of Turin. — M. Jacques Passé, assistant in the department of physiological psychology in Paris. — James Spencer, geologist and paleobotanist, July 9, at Akroydon. — Dr. G. Venturi, Austrian bryologist, June 5.

PUBLICATIONS RECEIVED.

(The regular Exchanges of the *American Naturalist* are not included.)

Beal, W. J. Seed Dispersal. Boston, Ginn & Company, 1898. vii, 57 pp., 8vo, 65 figs. — Deutscher Botaniker-Kalendar für 1899. Herausgegeben von P. Sydow. Berlin, Borntraeger, 1898. 198 pp.

Goto, S. Some Points in the Metamorphosis of Asterina gibbosa. *Jour. Coll. Sci. Imp. University, Tokio.* Vol. xii, Pt. iii, pp. 227–242, Pl. xviii. 1898. — Ikeno, S. Untersuch. u. d. Entwicklung der Geschlechtsorgane u. d. Vorgang d. Befruchtung bei Cycas revolta. *Jour. Coll. Sci. Imp. University, Tokio.* Vol. xii, Pt. iii, pp. 151–214, Pl. x–xvii. 1898. — Stejneger, L. On a Collection of Batrachians and Reptiles from Formosa and Adjacent Islands. *Jour. Coll. Sci. Imp. University, Tokio*, pp. 215–225. 1898.

Commissão Geographica e Geologica de São Paulo. Boletim No. 10. Alberto Löfgren: Ensaio para Uma Synonimia dos Nomes Populares das Plantas Indigenas da Estado de S. Paulo. São Paulo, 1895. — *Commissão Geographica e Geologica de São Paulo.* Seccoã Meteorologica. Dados Climatologicos da Anno, 1893–96. — *Commissão Geographica e Geologica de São Paulo.* Boletim Nos. 12–14. Alberto Löfgren: Flora Paulista, I–III. Compositæ, Solanaceæ, Scrophulariaceæ, Campanulaceæ, Curcubitaceæ, Calyceraceæ, Valerianaceæ. São Paulo, 1897. — *Denison University, Bulletin of the Scientific Laboratories.* Vol. x, Memorial Volume. Vol. xi, No. 1, Fowke, G. Preglacial Drainage in the Vicinity of Cincinnati, etc. No. 2, Bowmocker, J. A. The Paleontology and Stratigraphy of the Corniferous Rocks of Ohio. No. 3, Cockerell, T. D. A. Tables for the Determination of New Mexican Bees, 1898. — *Florida Agricultural Experiment Station.* Bulletins 46 and 48.. Quaintance, A. L. The Strawberry Thrips and the Onion Thrips, 114 pp., 12 figs., July, 1898. Preliminary Report upon the Insect Enemies of Tobacco in Florida, 33 pp., 16 figs., Oct., 1898. — *Geological Survey of Canada, Contributions to Canadian Paleontology.* Vol. i, Pt. v, No. 7. Whiteaves, J. F. On Some Additional or Imperfectly Understood Fossils from the Hamilton Formation of Ontario, with a Revised List of the Species Therefrom, 75 pp., 3 pls. 1898. — *Illinois State Laboratory of Natural History.* Biennial Report of the Director for 1897–98. — *Johns Hopkins Hospital Bulletin.* Vol. ix, No. 93. Dec., 1898. — *North Carolina Agricultural Experiment Station.* Bulletin 152. Hege, F. E. Poultry Notes, 22 pp. Sept., 1898. — *North Carolina Agricultural Experiment Station.* Bulletin 154. Withers, W. A. and Fraps, G. S. The Adulteration of Coffee and Tea offered for Sale in North Carolina. 13 pp. Dec., 1898. — *Maryland Geological Survey.* Vols. i–ii. 539 and 509 pp. Maps and plates. Baltimore, Johns Hopkins Press, 1897 and 1898. — *Open Court, The.* Vol. xiii. Jan. — *Rhode Island Agricultural Experiment Station.* Bulletin 49. Wheeler, H. J. and Adams, G. E. Is a Lack of Lime General in Rhode Island Soils? 16 pp. Nov., 1898. — *Staten Island Natural Science Association Proceedings.* Vol. vii, Nos. 1 and 2. Nov. and Dec., 1898. — *Wyoming Experiment Station.* Bulletin 37. Buffum, B. C. The Stooling of Grains. 35 pp., 2 figs. June, 1898.

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